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CLIMATE CHANGE AND ECONOMIC POLICIES IN APEC ECONOMIES

SYNTHESIS REPORT

Office of the Chief Economist
East Asia and Pacific Region

Vice President	James W. Adams (EAPVP)
Chief Economist and Sector Director, PREM and FP, EAP	Vikram Nehru (EASPR)
Task Team Leader and Lead Economist	Ahmad Ahsan (Office of the Chief Economist and EASPR)

PREFACE

This report is a synthesis of the background studies on Climate Change and Economic Policies prepared as part of the APEC Finance Ministers' Policy Initiatives of 2008.[1] Under this initiative the World Bank was asked to prepare studies on the current state of economic policies concerning climate change and recommendations for strengthening these policies. The findings from this study, the background studies on which this is based, are intended to stimulate dialogue on economic policies for mitigation and adaptation to climate change.

The synthesis presents a menu of options for fiscal, regulatory, trade and investment policies to reduce the emission of greenhouse gases (GHG), and increase the use of energy efficiency and renewable technologies. This report has been presented at the APEC Senior Finance Officials Meetings in September, 2010. The final version was tabled at the APEC Finance Ministers' meetings in November, 2010. The four background studies on which this synthesis is based are:

i. **Climate Change and Fiscal Policy:** The study examines four main themes: fiscal policy instruments for mitigation; the choices among carbon pricing and technology policies; energy sector issues in developing economies that affect these choices; and fiscal policies for adaptation.

ii. **Trade and Investment Policies to Promote Climate Friendly Technologies in APEC**: The study identifies the use and potential of climate friendly technologies (CFTs) and their promotion through investment and trade policies.

iii. **Assessing Capacity Building Needs for the Use of Market-Based GHG mitigation Instruments:** This study outlines a preliminary approach for the assessment of an economy's capacity to use market-based GHG mitigation instruments. It draws on the case of the Kyoto Protocol's Clean Development Mechanism in China and Indonesia to delineate the technical and institutional capacities necessary to successfully implement market-based instruments.

iv. **Research Papers on the Impact of Extreme Climate Events, Household Welfare, and Policy Responses**: This analyzes how poor households who live in areas vulnerable to climate change, mainly in the form of changes in rainfall and occurrence and severity of natural disasters, will be affected by extreme climate events. This analysis is conducted using detailed poverty, weather and geographic maps in three developing APEC member economies, Indonesia, Mexico and Vietnam and identifies policy options for strengthening adaptive capacity.

These studies were guided by a World Bank team led by Ahmad Ahsan (EASPR/OCE) and consisting of Syud Amer Ahmed (DECAR), Johannes Heister (EASER), Emmanuel Skoufias (PRMPR), Xueman Wang (LECCF) and Katherine Patrick (EASPR), under the guidance of Vikram Nehru, Chief Economist and Sector Director, PREM and FPD, EAP. Francis Ng (DECTI) provided important inputs concerning trade policy. Milan Brahmbhatt (PRMVP) and Michael Toman (DECEE) provided very helpful comments on an earlier draft of this synthesis study. The study on climate change and fiscal policy was prepared by an Australian National University team led by Professor Stephen Howes. The study on trade and investment policies to promote CFTs in APEC was prepared by a team from BAEconomics (Australia), led by Anna Matysek. The study on market readiness was prepared by a team from Ecofys (Germany) led by Niklas Höhne. The study on extreme climate events is based on country studies led by Emmanuel Skoufias and Luc Christiaensen (EASER/UNU-WIDER). These studies have benefited from comments and guidance by Jan P. Bojo (EASER), James Brumby (PRMPS), Steve Jaffee (EASER), Vijay Jagannathan (EASIN), Hironori Kawauchi (EASPR), John A. Roome (EASSD), Apurva Sanghi (GFDRR), and David Victor (University of California at San Diego). Mildred Gonsalvez (EASPR) provided valuable assistance in processing this report.

[1] Initiative Number 9. APEC, Finance Ministers' Policy Initiatives, 2008

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
APEC	Asia-Pacific Economic Cooperation
AR4	Intergovernmental Panel on Climate Change's Fourth Assessment report
ASEAN	Association of Southeast Asian Nations
CBA	Cost Benefit Analysis
CCT	Clean Coal Technology
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction units
CERC	China Electricity Regulatory Commission
CFT	Climate Friendly Technology
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CO_2e	Carbon dioxide equivalent emissions
CPO	Crude Palm Oil
DHC	District Heating and Cooling
EET	Established Environmental Technologies
EG	Environmental Goods
EGS	Environmental Goods and Services
EPP	Environmentally Preferable Products
ETS	Emissions Trading System
FDI	Foreign Direct Investment
FIT	Feed-in-Tariff
G20	Group of Twenty
GCS	Global Climate Services
GDD	Growth Degree Days
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLS	General Lighting Service
GW	Gigawatts (Thousand MW or Million kW)
GWh	Gigawatt-hours (Million kWh)
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Regulations
kcal	Kilocalories
kW	Kilowatts
kWh	Kilowatt-hour
LPG	Liquefied Petroleum Gas
MAC	Marginal Abatement Cost
MRV	Monitoring, Reporting, and Verification
$MTCO_2$	Metric Tonnes of Carbon Dioxide
MW	Megawatts (Thousand kW)
LPG	Liquefied Petroleum Gas
NAMA	Nationally Appropriate Mitigation Action
NDRC	National Development and Reform Commission
NGCC	Natural Gas-Fired Combined Cycle
NOAA	National Oceanic and Atmospheric Administration
NTB	Non-Tariff Barrier
OECD	Organization for Economic Cooperation and Development
PV	Photovoltaic
R&D	Research and Development
RGGI	Regional Greenhouse Gas Initiative
RPO	Renewable Purchase Obligations
SASAC	State-owned Assets Supervision and Administration Commission
SERC	State Electricity Regulatory Commission
SHS	Solar Home Systems
Tce	Tonne of coal equivalent
TNA	Technology Needs Assessment
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank

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EXECUTIVE SUMMARY

Background

1. ***This study has been prepared in response to the APEC Finance Ministers' Policy Initiatives of 2008***. Under this initiative the World Bank was asked to prepare studies and workshops on the implications of climate change for economic policies for Finance Ministries and related ministries to help strengthen policy making and implementation. This study synthesizes research in four policy areas: fiscal policies to address climate change, trade and investment policies to support climate friendly technologies, preparing economies to use market-based instruments for emissions reduction, and interventions against extreme climate events.

2. ***Addressing climate change will be a central development challenge for the world in the 21st century, and APEC economies are at the center of climate change issues***. Even a moderate 2 degree Celsius warming above pre-industrial levels will likely lead to more frequent extreme weather events such as floods and droughts which lower crop yields, and coastal storm surges and inundation that would increase the risks of catastrophic impacts. The consequences could include an estimated additional 100 million to 400 million persons at the risk of hunger, and an additional 1 to 2 billion people suffering from water shortage. APEC economies include the three largest emitters of greenhouse gases (GHGs) and together account for about 60 percent of all global emissions. Their actions to reduce emissions will be decisive in affecting climate change scenarios. Some economies within this group are also among the most vulnerable to climate change: China, Cambodia, Indonesia, Japan, Lao PDR, Mexico, Thailand, Philippines and Vietnam.

3. ***Many APEC economies, including developing economies, have already set ambitious, voluntary national targets to cap and reduce greenhouse gas (GHG) emissions.*** The policies required to meet these targets fit well with other national goals. These include: *first*, economies seeking to tackle national environmental problems; *second*, addressing energy security as dependence on energy imports and global energy prices rise (apart from Russia, Canada, Australia, and Brunei, APEC economies either already are or will become energy importers); *third*, seeking technological advantage, and using low-carbon technologies as a growth opportunity for the future. In this context, the report presents the seven main findings of this report.

Seven Main Findings of this Report

4. ***<u>First</u>, synergies between the emission reduction targets and other national goals, referred above, create a large zone of "no-regrets" policies***. "No-regrets" policies are policies for emissions reduction that also serve other development goals. For example, the greater uptake of renewable energies such as solar and wind power can facilitate rural electrification, which will help reduce rural poverty. In Vietnam, 16 percent of the population does not have access to electricity, while in Indonesia, 46 percent does not have access. The high cost of connection to the national grid is also a major barrier to greater electrification. As a result, policies that promote and finance off-grid renewable energy sources are "win-win" because they promote rural development and reduce emissions by producing electricity from non-fossil fuel sources.

5. ***But there are also trade-offs that will need to be addressed.*** An emissions reduction target on its own might worsen aspects of energy security, broadly defined as an economy's access to clean energy at reasonable prices. For example, higher fossil fuel prices to reduce emissions may drive poor households to traditional, inefficient sources of energy such as bio-mass or switch their source of power generation from coal to imported oil products with volatile prices. Conversely, some measures to reduce oil import costs or limit exposure to price volatility can increase emissions. Sometimes, however, a combination of

these targets can work well for APEC developing economies where the trade-offs are most acute. For instance, most of these economies want to reduce their reliance on both oil (because of trade balance and price volatility considerations) and coal (for climate change and local pollution reasons). Their climate change and local pollution targets discourage coal and total energy use. They can use clean and renewable energy targets to avoid a switching from coal to oil instead of to other cleaner energy technologies. This also promotes competitive advantage in what the economy sees as a future growth area.

6. ***Second, the ambitious emissions reduction and renewable energy targets of APEC economies will not be achieved unless the full range of economic policy instruments is used.*** The difficulty of achieving emissions reduction targets is illustrated by many developed economies' failure to reduce emissions in line with their Kyoto Protocol targets, as well as China's rapid emissions growth. This means that APEC economies will have to go beyond low cost no-regrets policies like supporting energy efficient buildings, and also consider higher cost policy interventions with fewer co-benefits, such as supporting R&D in carbon capture and sequestration technologies. The policy instruments chosen can make the difference between success and failure in meeting these targets. In the recent past, APEC economies used a mix of regulatory and technology-specific fiscal measures to achieve their goals. Carbon pricing, as an instrument, has been given lower priority. Given the ambitious targets currently in place, the time has come to consider the full range of instruments. These are discussed next.

7. ***Third, fiscal policies - taxation, pricing and public expenditures related to climate change mitigation and adaptation efforts – will be central.*** In mitigation there are five key aspects to consider.

- Carbon pricing will be critical as it provides the key incentive for reducing carbon content. It will also provide opportunities for "no-regrets" policies and double dividends. Reducing energy subsidies and raising carbon prices offers the scope for raising considerable revenues but also terms of trade gains for most APEC economies that are net energy importers. These can at least partially offset mitigation costs. Carbon pricing will, however, not be enough in many APEC economies, particularly where there are significant distortions in the energy sector.
- Energy sector reforms will be a prerequisite for making pricing effective in many economies. Of particular importance are policies that allow cost pass-through in the energy sector – so that subsidies do not re-appear, and so that carbon prices can be passed on. Without this, carbon pricing will lack both signaling power and credibility. Enabling cost pass-through will require liberalizing energy markets and establishing independent regulators, both formidable tasks.
- Broader economic reforms will also be important since other policies, e.g. fiscal and financial sector policies that under-price capital costs, may bias economic growth towards excessive capital and energy intensive technologies.
- Fiscal policy will need to support carefully chosen technology-based mitigation efforts. Most of the support will be for neutral policies such as promoting R&D and innovation. In some cases, however, specific technologies that show promise of lower costs in the future – such as coal gasification or carbon capture and sequestration – can be supported.
- Given the many uncertainties involved in these policy areas, and the expansive reforms needed, economies would find it helpful to anchor their portfolio of adjustable policy interventions around verifiable emissions quantity targets.

8. ***Fiscal policies for adaptation will require going beyond the costs of adaptation and their financing; they will also need to focus on choice of adaptation instruments and decision-making tools under conditions of uncertainty.*** The annual cost of adaptation in East Asia region is estimated to be at around USD 18 billion, for a world that is warmer by 2 degrees Celsius by 2050. This will need financing both through domestic sources and international transfers for the lower income economies. Equally important will be to ensure that adaptation expenditures are financing the right instruments. Adaptation

instruments include the provision of public goods (such as infrastructure), public service pricing reform (in particular of water) and financial instruments (microcredit and insurance) which can be cost-effective alternatives to subsidies. Key to the right choice of instruments (which will vary from location to location) will be the correct use of appropriate decision-making tools. In particular, the social costs and benefits of alternative strategies need to be analyzed under conditions of uncertainty, in many ways the hallmark of climate change. Popular tools such as Multi-Criteria Analysis, vulnerability indexes, and Cost-Effectiveness Analysis are inadequate to the task because of uncertainty. A combination of Monte Carlo analysis and 'real options' within a cost-benefit framework is recommended to provide flexibility and maintain policy options. Examples from a range of economies are provided.

9. ***Fourth, there is a diverse range of Climate Friendly Technologies (CFTs) used and produced in APEC economies.*** These technologies, at various stages of development, range from large-scale to micro-scale (household level), and relatively generic technologies to sector-specific technologies. Technologies in the energy sector are the most important for reducing GHG emissions. The most important demand-side technologies are those improving efficiency and energy conservation. These include building design improvements, combined heat and power (CHP) generation, efficient lighting systems, and automobiles. On the supply side, advanced fossil fuel based electricity technologies and renewable energy technologies, such as hydro-electric, wind-energy, bio-fuels, and solar photo-voltaic can significantly reduce emissions intensities. These technologies have to be used in concert as part of a complete mitigation strategy.

10. ***Middle-income APEC economies are well placed to take advantage of these CFTs through international trade and investment, and technology transfers if investment, trade and institutional issues are addressed.*** In the case of investment policy, access to adequate and affordable financing for investment will be critical. Providing certainty for investment policy decisions will be equally important. Greater use and production of CFTs need to be financed through technology neutral public investments (such as in R&D) and targeted financing mechanisms like the Clean Development Mechanism, corporate R&D, venture capital or asset financing, and funds raised on public markets. In international trade, high tariffs and non-tariff barriers on established environmental technologies impede wider use of CFTs. Standards, certifications, subsidies and environmental regulations, are among the major non-tariff barriers. Third, legal and institutional issues need to be addressed. Unclear legal and regulatory frameworks, insecure intellectual property rights, complex and overlapping institutions and lack of technical and planning capacity also have to be addressed to facilitate transfer of CFTs and enhance CFT use and production.

11. ***Fifth, increasing market-readiness – or the capacity of markets to transmit carbon price signals, measure and credit emission reductions, and trade emissions rights -- will be crucial for implementing climate change polices.*** Market-based instruments are important tools to achieve and finance GHG emission reduction since access to adequate and affordable financing for CFTs will be essential for expanding their use and production. The report takes stock of market-based mechanisms that are currently being used by developed and some developing economies, and which are being discussed for a post-2012 climate agreement.

12. ***In this regard, APEC economies in the East Asia region are already in a position to use fairly advanced market mechanisms to achieve mitigation in domestic markets or in bilateral trading.*** The market-based mechanisms discussed here include project-based offset mechanisms like the clean development mechanism (CDM) and allowance-based emissions trading systems (cap and trade). The report also considers other mechanisms under development, such as sector-based crediting and trading mechanisms, and crediting or payment systems based on nationally appropriate mitigation actions (NAMAs). However, developing economies will need to build institutional, technical and political capacity to be able to manage the complexities of these new instruments. Another fundamental requirement for using any of these mechanisms will be improved emissions inventories and strengthened monitoring, reporting and verification (MRV) capabilities. A diagnostic approach to market readiness

assessment is also proposed for APEC economies. Leading APEC economies should consider preparing themselves for the new market-based mechanisms and help shape the future of the carbon markets.

13. ***Sixth*, social safety nets, access to credit, irrigation infrastructure and targeting policies can help communities respond to extreme climate events.** The report emphasizes three findings based on detailed empirical and spatial research on Indonesia, Mexico, and Vietnam. First, extreme climate event policy responses have to be geographically specific as climate change impacts will vary even within economies. Second, it shows that communities with greater access to credit, irrigation infrastructure, and social safety net programs have more resilience against extreme climate events. In its research, the report considers the impact of low rainfall, flooding, and hurricane force winds on agriculture and rural communities. Building social safety nets in regions where safety nets are non-existent and strengthening safety nets in the regions where safety nets are in operation are key "no-regrets" policies that countries should already consider implementing as part of a development agenda. Finally, it identifies gaps in disaster relief systems that need to be addressed.

14. ***Seventh*, APEC is well positioned to use regional cooperation to advance climate change policies.** APEC's voluntary and non-binding framework may give it an advantage to make progress in these regional cooperation areas. This report identifies four areas of cooperation.

- Harmonizing trade policies regarding climate friendly technologies. If APEC economies harmonized their standards, labels, and certification for environmental goods, it would overcome a major non-tariff barrier to their international trade and increase usage. The "Energy Star" labeling program for energy efficient consumer electronics already in use in some APEC economies illustrates how voluntary labeling programs can help promote energy efficient products. Another action here would be to review and remove tariff peaks on environmentally friendly goods.
- Increasing coordination among regulatory systems that will that will enable the growth of regional markets for climate friendly products, as is being seen with the market for compact fluorescent lights as incandescent lights are phased out in multiple countries.
- Strengthening regional climate monitoring efforts to inform progress in mitigation efforts and long-run adaptation decisions. Providing accurate and timely information will facilitate regional collaboration. This is especially important for early warning systems, as in the case of the Pacific Tsunami Warning System, where many APEC members are already involved.
- Knowledge sharing through regional cooperation can substantially enhance technical and institutional capacity, in areas such as MRV of emissions. The World Meteorological Organization's regional climate centers – including centers in Beijing, Melbourne, Seoul, and Tokyo – illustrate how regional cooperation can expand the provision of climate information services and facilitate knowledge sharing. Cooperation between APEC economies in areas such as MRV protocols, would contribute to the global climate negotiation process under the UN Framework Convention on Climate Change by strengthening trust among key partners.

1. CONTEXT AND OBJECTIVES

1. ***This study has been prepared as part of the APEC Finance Ministers' Policy Initiatives of 2008***. Under this initiative the World Bank was asked to prepare studies on the current state of economic policies concerning climate change in APEC economies, recommendations for strengthening these policies and a capacity building program to strengthen policy making and implementation. The findings from this synthesis report and the background studies on which this is based, has been presented at the APEC Senior Finance Officials Meetings in September, 2010. The final version was tabled at the Finance Ministers' Meetings in November, 2010.

2. ***Addressing climate change will be a central development challenge for the world in the 21st century,*** with the largest impacts on developing economies and the poor**.** Although long term climatic change is inherently subject to uncertainty, the scientific consensus behind climate change is overwhelming.[2] The Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC, 2007), the consensus document by over 2000 scientists representing every economy in the United Nations, has concluded that "Warming of the climate system is unequivocal", that manmade "warming of the climate system is widespread and can be detected in temperature observations taken at the surface, in the free atmosphere and in the oceans". Green house gases (GHGs) – carbon-dioxide, carbon mono-oxide, methane – are increasing in the atmosphere, trapping radiated heat and raising global temperatures.

3. ***Recent research in APEC economies, including in the United States and in the People's Republic of China, also highlight the growing risks from climate change.*** The US National Oceanic and Atmospheric Administration (NOAA), has also concluded that global warming is undeniable. This study which covered 43 economies looked at 10 indicators including shrinking glaciers, melting spring snow cover in the Northern Hemisphere, declining sea-ice in the Arctic, sea-surface temperature, higher air temperature over land, air temperature over oceans, humidity and temperature in the troposphere, and oceans. It noted that each of the last three decades was warmer than the previous one. The study in the USA is complemented by recent research from China. Continuous measurements from meteorological stations show that China has warmed by nearly 1.2 degrees Celsius over the past half century, with the north warming more quickly than the south (Piao et al., 2010). Heat waves have become more common as have the frequency of floods and droughts, vital river feeder glaciers are in retreat and the seven warmest years have all occurred in the past decade. The research notes that "China experienced explosive economic growth in recent decades, but with only 7 percent of the world's arable land available to feed 20 percent of the world's population, China's economy may be vulnerable to climate change itself".

4. ***Global warming is predicted to have wide ranging impact on human life***. Even a 2 degree Celsius warming above pre-industrial levels is likely to lead to increased weather variability, more frequent or extreme weather events such as floods and droughts caused by large changes in precipitation, and coastal storm surges, which would increase the risks of catastrophic impacts. The consequences could include an estimated additional 100 million to 400 million persons at risk of hunger, and an additional 1 to 2 billion people suffering from water shortage.

5. ***Climate change cannot be managed unless growth in both developed and developing economies becomes less greenhouse-gas-intensive***. Technology choices made now can lock the world into a high carbon intensity trajectory and thus increase the severity of global warming. The average global temperature has increased by 1 degree Celsius since the start of the industrial age and, if unmitigated, is expected to rise by 5 degrees by the end of this century, leading to potentially catastrophic consequences (World Bank, 2010a)**.**

[2] Climate change is the technically more accurate term than global warming for the phenomenon confronting the world. In this study, however, climate change and global warming are used inter-changeably.

6. ***APEC economies will have a decisive role in affecting climate change***. APEC economies include the largest emitters of GHGs – and together account for about 60 percent of all global emissions and two-thirds of CO_2 emissions. Advanced industrialized economies in APEC are the largest contributors to the stock of GHGs in the atmosphere today, and APEC economies, in total, will likely be the largest source of future flows of GHGs in the atmosphere. The USA is no longer the world's largest emitter, but it is responsible for the greatest volume (21 percent of the stock of $MtCO_2$ equivalent) of accumulated emissions. Without US leadership and the leadership of all advanced economies, it is unlikely that the world will be able to mount an effective mitigation response to climate change. Among developing economies, China's rise to industrial power status has accelerated global emissions growth, contributing about 25 percent of global CO_2 from fossil fuels in 2009, although its per-capita emissions remain considerably lower than that of the advanced economies. More generally, developing economy emissions have been growing rapidly and, absent the introduction of policies to mitigate climate change, will continue to do so. Also important will be the need to set up arrangements to provide finance and technology transfers from developed to developing economies within APEC to support mitigation and adaptation efforts. This could be modelled along the lines of the Copenhagen Green Climate Fund and Technology Mechanism agreed to as part of the Copenhagen Accord.

7. ***On the other side, several economies in the APEC region, such as China, Indonesia, Japan, Mexico, Philippines, and Vietnam have been identified to be among economies most likely to be affected by climate change.*** These economies will be impacted particularly by floods, storms, and coastal inundation (Table 1.1, below). The two hundred million people living in the coastal areas of China and Vietnam and on low lying islands of the Philippines and Vietnam are among the most vulnerable in the APEC economies. Another source of vulnerability is the critical role of precipitation in affecting agriculture and the rural economy on which the majority of the people depend in most APEC economies. The effect here can be two-fold: both higher precipitation in a shorter season and a lengthening of the dry season in places like Indonesia, Vietnam, Mexico and the Mekong Subregion.

Table 1.1: Economies Most at Risk from Droughts, Floods, Storms and Sea-Level Rise

Drought	Flood	Storm	Coastal 1 meter rise	Coastal 5 meter rise
Malawi	Bangladesh	***Philippines***	All low-lying Island States	All low-lying Island States
Ethiopia	***China***	Bangladesh	***Vietnam***	Netherlands
Zimbabwe	India	Madagascar	Egypt	***Japan***
India	***Cambodia***	Vietnam	Tunisia	Bangladesh
Mozambique	Mozambique	Moldova	***Indonesia***	***Philippines***
Niger	***Lao PDR***	Mongolia	Mauritania	Egypt
Mauritania	Pakistan	Haiti	***China***	Brazil
Eritrea	Sri Lanka	***Samoa***	***Mexico***	Venezuela
Sudan	***Thailand***	***Tonga***	Myanmar	Senegal
Chad	***Vietnam***	***China***	Bangladesh	***Fiji***
Kenya	Benin	Honduras	Senegal	***Vietnam***
Iran	Rwanda	***Fiji***	Libya	Denmark

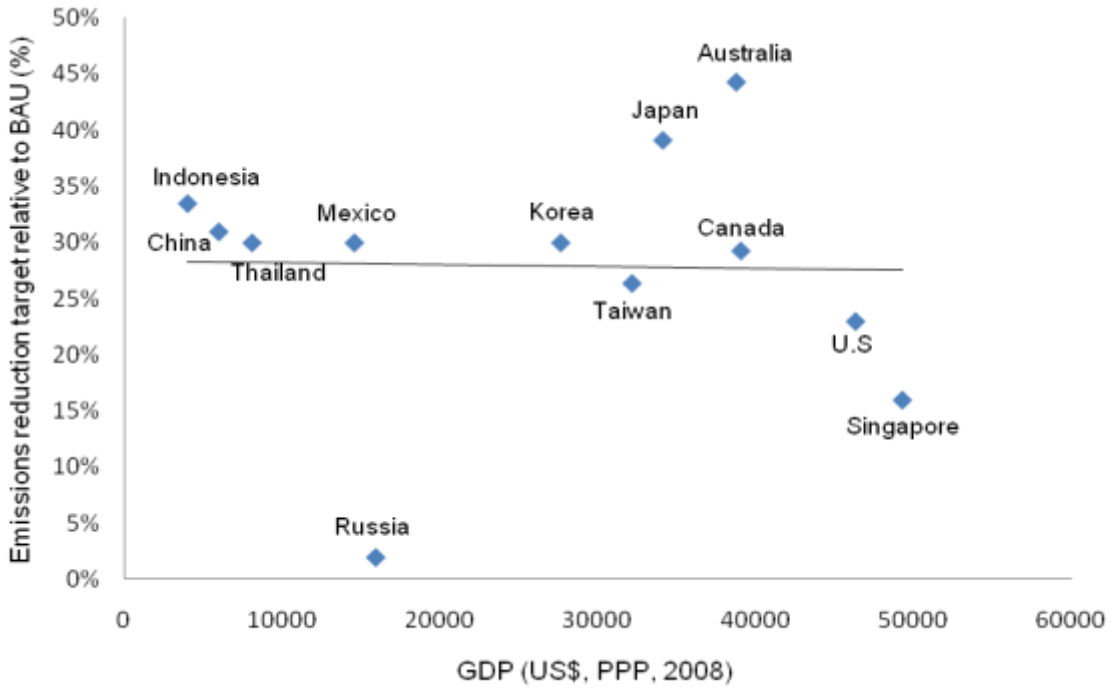
Note: The bold and italicized economies are APEC economies and Pacific Island countries.
Source: World Bank (2010a, 2010b).

8. ***The central role of APEC economies in affecting climate change presents an opportunity for APEC to provide leadership on its global sustainable growth agenda.*** For this to happen, climate change needs to enter the mainstream development agenda in APEC economies, and central economic agencies have to become engaged. Finance ministries, trade ministries and economic planning agencies will benefit from improving their understanding of the implications of climate change and policies to mitigate

its effects and adapt to its consequences. Recognizing this, in 2008, the APEC Finance Ministers Meeting took up the issue of climate change calling for further work "to understand the economic and market impact of policy and business responses to deal with climate change" (APEC Joint Ministerial Statement, 2007). This work was made a Finance Ministers' Policy Initiative in 2008 and the World Bank and the Government of Australia was given the task to prepare studies and a program of assistance on economic policy responses to climate change.

9. ***Many developed and developing economies have decided that "business as usual" is no longer an option, and have adopted ambitious self-imposed targets to reduce their emissions growth.*** Recognizing the urgency of a global response to climate change, many developing economies recently made non-internationally-binding commitments through the Copenhagen Accord to constrain the growth of their own emissions in the absence of a finalized global climate change agreement. There is little difference between the ambition of APEC developed and developing economy members; if anything, the latter are actually more ambitious (Figure 1.1).

Figure 1.1: Many APEC Economies have set Ambitious Emissions Targets



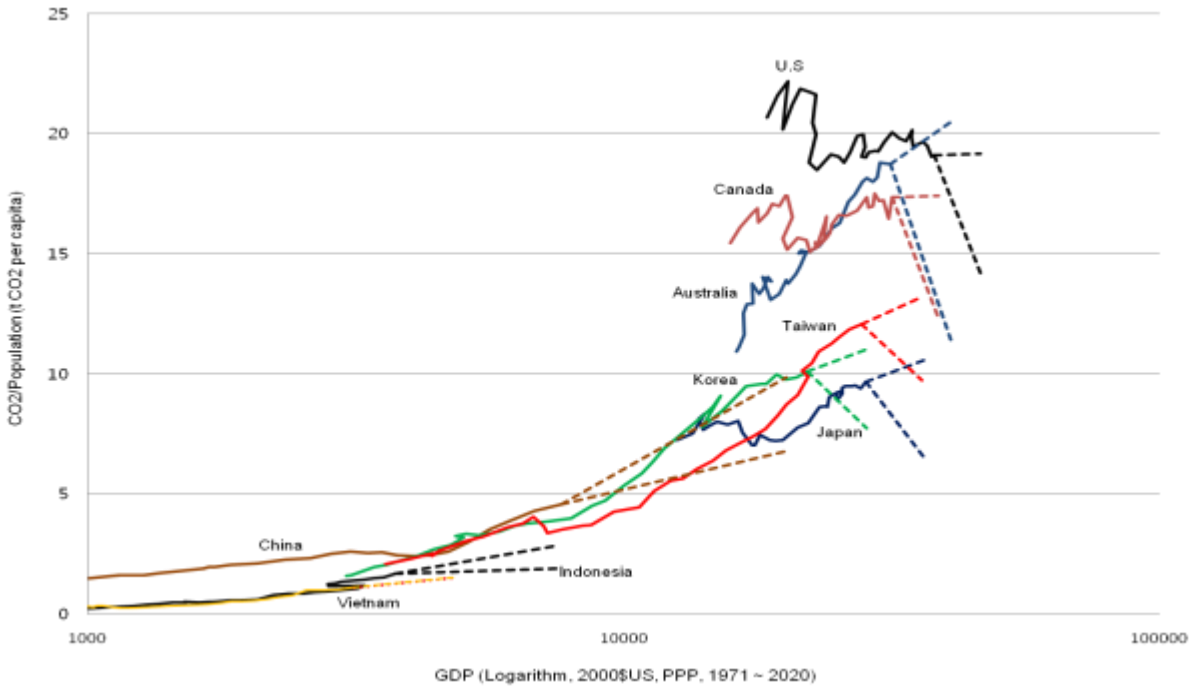
2020 APEC targets expressed as a reduction relative to business as usual (BAU)

Notes: Where a target range has been committed to, the mid-point of that range is selected. Targets are as recorded under the Copenhagen Accord, except for Taiwan. It should be noted that emissions reduction commitments or proposed commitments vary widely in their structure. For example, China's planned reductions involve a 40-45 percent reduction in carbon intensity relative to 2005, Australia's involve 5-10 percent reduction below 2000 levels, while Japan's involve 25 percent reductions below 1990 levels. These diverse emissions reduction targets were then the basis of emissions reduction targets relative to BAU, as estimated in World Bank (2010c).
Source: World Bank (2010c)

10. ***If implemented, these targets will fundamentally alter the emissions trajectories of APEC economies (Figure 1.2)***. Under business as usual, by 2020, China will resemble present day Korea in both per capita income and per capita emissions, which at 10 tonnes of CO_2 per person, is more than double China's current level. However, the scenario will be very different if the APEC economies achieve their national targets. There will be some convergence of per-capita emissions between developed and

developing economies. Developed economies will have shown that significant absolute emissions reductions are possible and developing economies will avoid a massive increase of emissions. For example, China's per capita emissions at the end of the decade will be 7 rather than 10, which equates to a savings of about 4 billion tonnes of CO_2.

Figure 1.2: Adhering to National Commitments will Mean a Very Different Emissions Future for APEC



Notes: Solid lines are historical. Upper dotted lines show business as usual. Lower dotted lines show trajectories assuming an adherence to national commitments. The historical period covered is from 1971 to 2007. The projection period is from 2007 to 2020. Emissions per capita are assumed to grow/decline in a linear manner over the projection period. These graphs are based on the simplifying assumption for most economies that targets announced for all greenhouse gases will be adhered to for CO_2 as well. Where a target range is provided, the mid-point of that range is selected.
Source: World Bank (2010c).

11. ***A large number of APEC economies have embraced renewable or clean energy targets.*** Worldwide, renewable energy targets are more popular than mitigation targets, with the former established in at least 73 economies globally as of 2009. Fourteen APEC economies now have ambitious renewable energy targets.

12. ***Why have many APEC developing economies adopted climate change and clean energy targets?*** To answer this question, it is important to understand how mitigation objectives and targets sit within the broader policy goals of many APEC developing economies. On one side, economies are increasingly worried about the impact of climate change. But three other goals are also driving action. *First*, economies are seeking to tackle national environmental problems. *Second*, energy security is a growing concern, as dependency on energy imports and global energy prices rise. Apart from Russia, Canada, Australia, and Brunei, APEC economies either already are or will become energy importers. *Third*, economies are also seeking technological advantage, and see low-carbon technologies as a growth opportunity for the future.

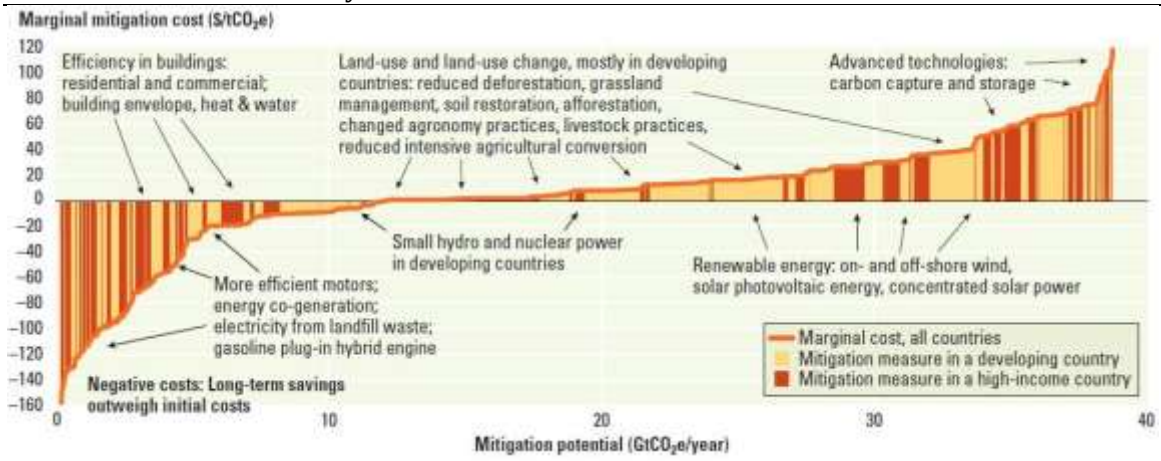
13. ***There are synergies between these goals***. Global action on climate change that reduced demand for fossil fuels and thereby pushing down global energy prices would improve the terms of trade for most APEC developing economies. Improvements in the terms of trade, as well as use of carbon revenue to

offset other taxes, would at least partially offset the costs of mitigation. Thus there could be double dividends from mitigation policies. For example, China could benefit in the short-term from global emissions reduction because of terms of trade benefits in addition to large revenue gains, which is elaborated later in this report. At the same time, economies need to be careful not to use the carbon revenue to create distortions in other areas, such as by inappropriate tax expenditures or supporting low-value investments.

14. ***There is a large "no-regrets" zone for mitigation policies: i.e. policies that are good for emissions reduction and that can also serve other development goals***. For example, the greater uptake of renewable energies such as solar and wind power can facilitate rural electrification, which is known to help reduce poverty (World Bank, 2000). In Vietnam, 16 percent of the population does not have access to electricity, while 46 percent do not have access in Indonesia (IEA, 2006). The high costs of connection to the national grid are a major barrier to greater electrification. As a result, policies which promote and finance off-grid renewable energy sources are "win-win" because they promote rural development and reduce emissions by producing electricity from non-fossil fuel sources.

15. ***Many "win-win" emissions reducing measures with net economic benefits are already being implemented.*** Figure 1.3 represents a potential global marginal abatement cost curve including various mitigation measures, with the width of each bar indicating the amount of emission reduction each measure would achieve and the height indicating the measure per tonne of avoided emissions. Tracing the height of the bars creates a marginal mitigation cost curve.[3] Although developed and developing economies have similar potential for net benefit measures and high-cost measures, the middle range of low-cost mitigation options is predominantly in developing economies**.** As discussed in Chapter 3 of this report, net benefit measures including energy efficiency, use of landfill gas, energy cogeneration, small hydropower, inter alia, are already being used in many middle-income APEC economies, with potential for further uptake.

Figure 1.3: Global Greenhouse Gas Mitigation Marginal Cost Curve beyond 2030 under the Business as Usual Scenario



Source: Reproduced from World Bank (2010a) based on data from McKinsey & Company (2009)

[3] It is important to add the caveat that this McKinsey marginal abatement curve is a potential cost curve that by design does not include a whole range of relevant costs including those associated with reducing price distortions, increasing awareness and institutional capacities for technology change, shake-out periods for new technologies, and so forth. The actual MC curve will have larger costs or smaller negative costs for almost all the listed items.

16. ***But there are also trade-offs that need to be addressed.*** An emissions reduction target on its own might worsen aspects of energy security, broadly defined as an economy's access to clean energy at reasonable prices. For example, higher fossil fuel prices to reduce emissions may drive poor households to traditional, inefficient sources of energy such as bio-mass or switch their source of power generation from coal to imported oil whose price is more volatile. Conversely, some measures to reduce oil import costs or limit exposure to price volatility can increase emissions. Sometimes, however, a combination of these targets can work well for APEC developing economies where the trade-offs are most acute. For instance, most of these economies want to reduce their reliance on both oil (because of trade balance and price volatility considerations) and coal (for climate change and local pollution reasons). Their climate change and local pollution targets discourage coal and total energy use. They can use clean energy targets to ensure that targets that discourage the use of coal does not cause an increase in the demand for oil. This also promotes competitive advantage in what the economy sees as a future growth area.

17. ***APEC economies will have to consider a range of policy options in order to reach their ambitious emissions reduction and renewable energy targets.*** This means that in addition to adopting no-regrets policy like energy efficiency and hydroelectric power, APEC economies will have to consider other technologies, like advanced carbon capture sequestration that do not have short-run co-benefits and that will require policy support to become economically viable.

18. ***The instruments chosen can make the difference between success and failure***. In the recent past, APEC economies used a mix of regulatory and technology-specific fiscal measures to achieve their goals. Carbon pricing, as an instrument, has been given lower priority. Given the ambitious targets currently in place, now is the time to consider the full range of instruments. In the absence of a global climate change agreement, APEC economies adopted an experimental and gradualist approach that considers a range of different policy options, but one that will have to confront the issue of carbon pricing as an essential condition for attaining emission reduction targets.

19. ***This chapter has shown that action on climate change requires a wide range of economic policy interventions. In the rest of this report,*** Chapter 2 discussed fiscal policies for mitigating emissions and adapting to climate change. It emphasizes the need for complementary policies that support technology-based approaches. Emissions reduction through appropriate climate friendly technologies (CFTs) can be an important complement to more politically sensitive mitigation measures (like carbon pricing). At the same time, CFTs provide co-benefits like rural electrification. This leads to the discussion of both neutral and technology specific policies for CFTs in Chapter 3 (Trade and Investment Policies to Promote Climate Friendly Technologies in APEC), discussing the current status of various technologies in APEC economies (emphasizing their current use, production, and trade). Financing these policy interventions – both technology based and otherwise, brings us to Chapter 4. This chapter discusses various efficient market mechanisms to reduce mitigation costs, and facilitate financing of mitigation efforts, while channeling fiscal, trade and investment policies**.** Chapter 5 turns to another aspect of adaptation responses. It provides a discussion of policy responses to extreme climate events and their impact on the poor at the community level. Climate change is inherently of a cross-border, regional and even global nature. Chapter 6 provides some initial thoughts on the scope for regional cooperation to address climate change issues.

2. CLIMATE CHANGE AND FISCAL POLICY

2.1 Goals and Targets: Climate Change Mitigation and Related Policy Objectives

1. ***This section looks at fiscal policy in relation to both mitigation and adaptation.*** Fiscal policy is the central policy tool for governments in all cross-cutting issues and climate change is not an exception to this. Fiscal policy directly affects prices, incentives and government investment plans key levers in the allocation of resources in economies. The main focus is on mitigation. This allocation of space does not reflect any judgment on the relative importance of mitigation and adaptation. Rather, the field of fiscal policy and adaptation is in its infancy.

2. ***In relation to mitigation, the focus is on carbon dioxide (CO_2) from fossil fuels.*** Unless otherwise stated, data is for CO_2 (often simply referred to as 'emissions') from fossil fuels. This is the largest single source of greenhouse gases, and the fastest growing. Almost 80 percent of greenhouse gas emissions are in the form of CO_2. About one-quarter of this is through deforestation. The rest is from fossil fuels. Electricity generation is the largest single source of fossil fuel emissions, and a special focus of this report. Other sectors also burn fossil fuels, including transportation, industry, services and households.

2.2 The Instruments: Fiscal Policies for Mitigation

3. ***Climate change mitigation instruments can be divided into carbon-pricing and technology-based policies.*** Carbon pricing policies include a carbon tax, emissions trading schemes, and hybrids of these two approaches. All other policies are labeled technology-based (or, simply, technology) policies because they are all, to some extent or another, technology-specific. A feed-in tariff can only be fixed for a type (or types) of technology. Clean energy targets and research and development subsidies have to be defined in relation to a set of "clean" technologies. Carbon pricing instruments, in this sense, are, by contrast, technology neutral: they do not require the government to 'pick winners'. Carbon pricing instruments are by definition fiscal, whereas technology-based instruments can be fiscal or regulatory. Table 2.1 provides a (non-exhaustive) classification of policy instruments along these lines.

Table 2.1: Classification of Climate-Change Mitigation Instruments

Carbon pricing	Technology-based	
Fiscal	Fiscal	Regulatory
-Emissions trading -Carbon tax -Hybrid trading-tax schemes	-Demonstration grants -Public R&D -Investment subsidies -Public investment in Venture Capital -Public investment vehicles -Feed-in tariffs -Tax credits -Public procurement -Renewable energy certificate trading -Subsidies for energy-efficiency purchases	-Improving information availability -Technology performance standards -Renewable fuel/energy standards -Building regulations -Automobile regulations -Information standards

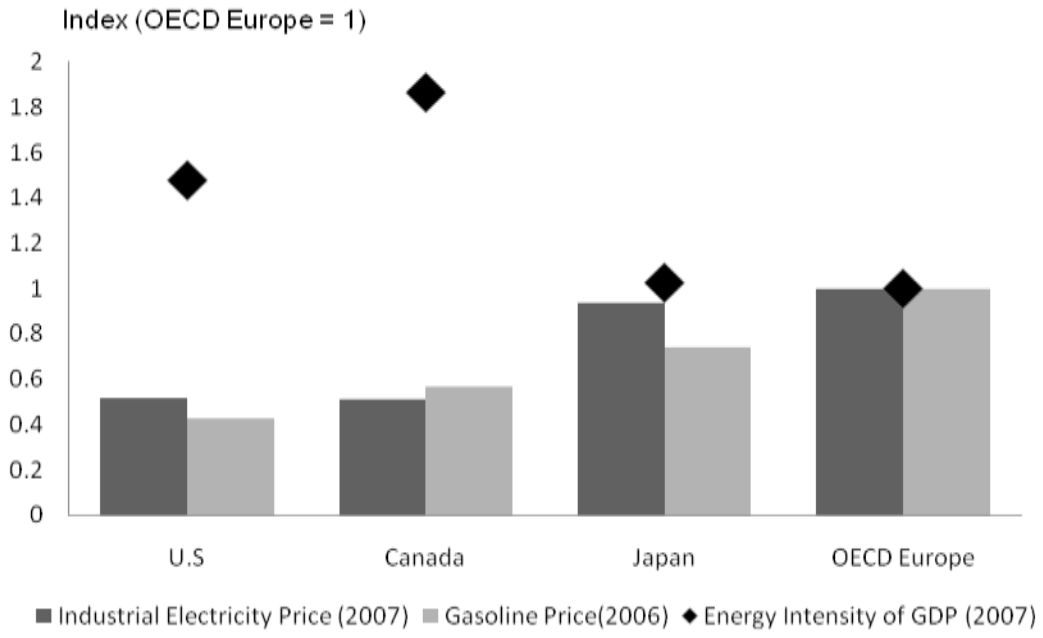
4. ***Broader policies and structural reforms are also important for climate change mitigation.*** All parts of the economy use energy and emit CO_2. Energy sector reforms in particular and economic reforms more generally can have a powerful impact on emissions trajectories. This is a theme picked up later in the report.

2.2.1 Carbon Pricing

5. ***Carbon pricing is essential for effective climate change mitigation***. By pushing up the relative price of emissions intensive goods, a carbon price reduces emissions in four ways. First, it pushes consumer demand in the direction of goods which are less emissions intensive (so people will wear extra clothing and turn down the heating, for example). Second, it induces suppliers to make their goods less emissions intensive (say, to make electricity with gas instead of coal). Third, it leads investors to invest in less emissions-intensive projects (to build gas-fired power stations instead of coal fired ones).[4] And, fourth, carbon-pricing gives a financial incentive for innovators to develop new products, which are less emissions-intensive.

6. ***International comparisons of energy prices and usage point to the importance of pricing as a determinant of energy efficiency***. To simplify somewhat, the message from Figure 2.1 is that the USA and Canada have electricity and gasoline prices at 50 percent below the levels prevailing in Japan and Europe, and energy per unit of output at 50 percent above. No doubt the relationship is two way (with higher energy intensity in North America leading to political resistance to tax hikes), but it seems reasonable that higher energy prices will encourage energy efficiency, and that, as a special case of this, the introduction of carbon pricing will discourage fossil fuel use. The European Union's experience with emissions trading confirms that putting a price on emissions leads to abatement.

Figure 2.1: Developed Economies have Low Energy Prices or High Energy Efficiency, but not both



Note: Electricity prices, gasoline prices, and energy intensity (ratio of energy use to GDP) for US, Canada, Japan and the OECD member countries of Europe. All European values are normalized to one.
Sources: IEA (2009, 2010)

7. ***To date, however, little use has been made of carbon pricing. Technology-based policies have been much more popular***. Among APEC economies, only New Zealand, and some American and Canadian states and provinces have actually introduced a jurisdiction-wise price on carbon. In some

[4] In a world of partial mitigation, suppliers and investors may also respond by moving emissions-intensive production off-shore. This is the problem of carbon leakage.

economies, carbon pricing is still politically controversial, and it will remain so until adopted by the world's largest economies. APEC economies, including developing ones, are, however, showing increasing interest in carbon pricing. Within APEC, only New Zealand and some US states have actually introduced Emissions Trading Schemes. Emissions trading schemes are being prepared or debated in the USA, Australia, Japan, and Korea. China and Indonesia are both contemplating the introduction of carbon pricing. Both a carbon tax and emissions trading seem to be under consideration in China. Some developing economies (in and out of APEC) have already introduced carbon-price-like levies, including India, Vietnam and China.

8. ***A carbon price signal can be introduced either through a price-based approach (e.g. a carbon tax) or a quantity-based approach (e.g. an emissions trading scheme), or a combination of the two***. Under conditions of certainty and perfect information, a carbon tax and emissions trading scheme are equivalent. In the real world, there are pros and cons to both approaches. Most models show that carbon pricing will be more costly to developing than to developed economies without international transfers. However, the revenue benefits of carbon pricing could be substantial, especially in developing economies. A $20 carbon price applied across fossil fuels could fetch China in excess of 2.5 percent of GDP by 2020. If this revenue is used to reduce other taxes, or to support productive spending, then the costs of carbon pricing would be reduced. With terms of trade gains, carbon pricing could induce short-term economic gain as well as long-term GHG mitigation and local environmental protection. That said, there has been little analysis of how a carbon price would operate in a developing economy. The analysis of the report fills this gap, and is reported on below.

2.2.2 Technology-Based Policies

9. ***Governments have a wide-range of reasons for introducing technology-based policies. The main reasons are the following***:

- As this report has already discussed, many governments have renewable energy targets and industrial policy objectives. Technology-based policies complement carbon price policies for meeting these clean energy targets and industrial policy objectives. Inventions and discoveries are public goods. Firms under-invest in research and development because of the fear that their competitors will benefit. Trading off the need to provide incentives to invent (prior to the invention) and the need to make maximum use of any inventions (once they are made) is an important task for governments which they undertake not only through patent systems but also through public funding for R&D. If climate change mitigation and clean energy are important social goals, then they will also be claimants on the public R&D budget. APEC, led by Japan, dominates global innovation in climate change technologies. According to Dechezleprêtre et al. (2008), eight of the top twelve most inventive economies in the area of climate change mitigation are in APEC, with Japan alone being responsible for 37 percent of the world's climate change mitigation inventions. The USA is in second position, and China, South Korea and Russia in 4th, 5th and 6th positions respectively. China's recent Medium and Long-term Development Plan for Renewable Energy in China (2007) explicitly identifies the deployment of Chinese intellectual property domestically as a future policy objective. Other middle-income APEC economies, such as Malaysia, also give heavy emphasis to innovation, which they see as critical for escaping the so-called 'middle-income trap.'

- Public promotion of technologies can be justified in consideration of dynamic increasing returns generated by learning-by-doing, learning-by-using and network externalities. Successful innovation is a long and arduous process. Lee et al. (2009) estimate that the average period for taking a new energy technology to market – to traverse the 'valley of death' as it is often called – is 20 to 30 years. In such an environment, early-movers generate spill-over effects which are of benefit to society but cannot be privately appropriated. Support from governments through

technology-based policies is needed to encourage firms at all stages to be first-movers throughout the innovation process.

- The third rationale for technology policies rests on capital market failures. Research has shown that the combination of large upfront costs and high risk profiles can make renewable energy demonstration projects unsuitable for both venture capital and commercial financing and therefore leave them with inadequate market financing.
- Policy risk is unavoidable for renewable energy. Given that no renewable energy has yet reached price parity in its production costs with coal-fired electricity, a profitable return on the development of these technologies may be dependent on many years of policy support, whether through a carbon price or other potential means like a direct subsidy. This once again makes renewable energy projects quite different from other areas of high innovation, such as IT and biotech projects. Technology-based policies can help reduce policy risk by providing upfront support that makes projects bankable (e.g. through carefully targeted capital subsidies, investment risk cover, or partial output purchase agreements) rather than over time. On the other hand, support that needs to be provided over time to reduce risks should be embedded into legally binding frameworks (e.g. through feed-in tariffs).
- Technology-based policies are not only about new technologies. A range of information and agency barriers can restrict the use of known technologies, including those for greater energy efficiency. In the most well-known case, landlords, who pay for capital costs, will under-invest in energy efficiency, since the benefits in terms of reduced energy bills will flow to their tenants. Or consumers, because they lack information, will judge durables on the basis of upfront rather than lifetime costs. The policies to respond to these market failures are not analyzed in detail in this report, which focuses on innovation, but they are technology-based policies, and the general lessons which are drawn about technology-based policies apply to them as well.
- Finally, technology-based policies can sometimes be considered substitutes for rather than complements to carbon pricing. As noted, carbon pricing is still controversial in many economies. Some economies have shown themselves unwilling to introduce carbon pricing but willing to implement technology-based policies.

10. ***The vast array of technology-based fiscal measures can be divided into two groups***. Demand-side (or demand-pull) measures are policies where the government acts to increase demand for a technology. Supply-side (or technology-push) measures refer to policies where the government tries directly to reduce the (private or social) cost of a technology it wishes to promote. In the next two sections, each is considered in turn.

11. ***Supply-side and demand-side policies are often substitutes***. Experience suggests both can be effective in expanding renewable energy. For example, wind power capacity has expanded rapidly in recent years in both China and the USA, but using different approaches. China has relied largely on renewable energy targets, the USA on production tax credits.

12. ***While no doubt supply-push technology policies can induce strong results, they must be considered on a case by case basis***. Germany's PV solar power feed-in tariff is a well-known case of failure. The high tariff used in Germany has been successful at getting greater use of PV solar in Germany (which now has the highest installed PV capacity of any OECD country), but at great expense. Frondel et al. (2010) calculate the cost of emissions savings brought about through this scheme at 716 Euro per tonne of CO_2, suggest only modest benefits in terms of cost-reduction, and in fact note some perverse incentives which might have actually pushed costs up. Likewise, the biofuel policies adopted by many economies have resulted in serious concerns about their environmental and economic impact, leading to the Consultative Group on International Agricultural Research Science Council (2008) calling for governments to "scale back their support for and promotion of biofuels" until better technologies are

available. And a large home insulation scheme in Australia designed to promote energy efficiency had to be abandoned amidst growing concerns relating to safety and fraud. More generally, some of the outcomes sought by technological policies (such as cost reductions and technological breakthroughs) are inherently difficult to observe, and harder still to attribute to policies.

13. ***The discussion so far is summarized in Table 2.2***. The report has identified that many APEC economies have adopted both emission reduction and clean energy promotion targets. These have been put in place to achieve four higher-level economic, security and environmental policy goals: the mitigation of climate change, promotion of energy security, reduction of air pollution, and the pursuit of competitive advantage. To achieve these targets, economies have a range of instruments to choose from. They can choose regulatory and/or fiscal policy instruments. Among fiscal policy instruments, they can choose carbon pricing and/or technology-based instruments. They can also pursue structural reform in pursuit of their targets.

Table 2.2: Goals, Targets and Instruments in Climate Change and Related Areas

Goals *(Reasons for introducing the targets)*	• Climate change mitigation • National pollution reduction • Energy security enhancement • Search for competitive advantage
Targets	• Emission reduction targets • Clean energy targets • Others (e.g. national pollution standards, energy efficiency targets)
Instruments *(Means to achieve the targets)*	• Carbon pricing • Technology-based fiscal polices • Regulatory instruments • Structural reforms

14. ***The remainder of the report takes economies' targets and goals as given and focuses on the choice of instruments.*** To date, most discussions of fiscal policy for climate change mitigation has been in a developed economy context. A number of reviews (such as the Stern Review, 2006, the Garnaut Review, 2008, or Burniaux et al., 2008) provide a good idea of the policies needed for developed countries. Carbon pricing is universally recommended as essential, and then a range of other complementary policies is also recommended. There is less agreement on this range of complementary policies, but typically they include policies to support new technologies and to address other market failures which might block action.

15. ***In other areas of economic policy, structural differences between developed and developing economies are given appropriate recognition, and provide the basis for differences in policy recommendations.*** A similar approach is needed for climate policy. Although no single answer can be given for all countries, there are characteristics of many developing countries, in particular in the energy sector, which need to be taken into account when making policy choices in the area of mitigation.

2.3 The Context: Energy Sector and Other Important Economic Characteristics Relevant to Instrument Choice

16. ***The theories which support the introduction of various fiscal policies to mitigate climate typically assume that energy prices already reflect economic costs, and that the energy sector, comprised of profit-maximizing companies, runs along commercial lines***. In such an environment, a focus on carbon pricing to internalize the environmental externality of climate and other technology-based policies to correct the various market failures along the innovation chain is clearly warranted.

Research undertaken for this report on China, Vietnam, Indonesia, as well as other cross country studies show that in many developing economies the situation can be quite different.

17. ***The results are summarized in Table 2.3, which compares China, Vietnam and Indonesia with a stylized typical developed economy.*** (Developed economies show little variation in regard to these characteristics, so in most areas generalizations can be safely made, and the table notes where this is not the case.) A rating scale of 'low', 'moderate' and 'high' is used, and characteristics are worded so that the typical developed economy scores a 'low' for most of the 15 criteria. The report has a particular focus on the energy sector, and, within that, on electricity since this is the most important, and by far the most rapidly growing source of CO_2 emissions. However, some broader economic features of developing economies are also discussed. Table 2.3 examines 15 criteria – 12 in relation to the energy sector, and another 3 more broadly.

18. ***The point of Table 2.3 is that developing economies do tend to differ from developed ones in some pretty important ways with respect to their energy sector and more broadly.*** Developing economies tend to experience high energy, and especially electricity growth. Despite this, they still have up to half their population dependent on traditional fuels for cooking and heating; and the benefits from access to the modern electricity sector are regressively distributed (not progressively as in developed economies). Energy subsidies are prevalent in developing economies. Just as important, but less frequently commented on, price setting is still political rather than market-oriented, and mechanisms for cost pass-through in the energy sector are underdeveloped. In many developing economies, the energy sector is neither liberalized nor subject to independent regulation. Due to a combination of rapid growth in demand, and financial constraints associated with subsidies, energy shortages are common, and in some economies the private sector responds to this through the construction of captive power. There is often little flexibility in electricity dispatch, not only because of shortages (so that everything that can be will be dispatched) but also because of transmission constraints and policy settings.

19. ***The energy sector tends to be dominated by vertically-integrated state-owned utilities.*** Especially in the electricity sector, investment expansion is planned centrally. The relationship between the government and the dominant utility or utilities lacks a commercial orientation. Many developing economies have tried to reform their energy sector, but have found reforms to be difficult, especially in electricity. More broadly, some developing economies suffer from factor market distortions, such as financial repression, which make their growth more capital and energy intensive than it would otherwise be. They have limited instruments to compensate households for price increases, and they have weaker institutional capacity than developed economies.

Table 2.3: Characteristics of the Energy Sector and the Broader Economy of Developing Economies (China, Vietnam, and Indonesia) and a Typical Developed Economy

Characteristics relating to the energy sector (with emphasis on the power sector)				
	Typical Developed Economy	**Developing Economies**		
		China	**Vietnam**	**Indonesia**
1. Rate of energy growth	Low	High	High	High
2. Importance of traditional energy sector	Low	Moderate	Moderate	Low
3. Likelihood that energy expenditure share rises with consumption	Low	High	High	High
4. Presence of subsidies	Low	Moderate	Moderate	High
5. Degree of political discretion in price setting	Low	Moderate	Moderate	High
6. Degree of rationing	Low	Moderate	High	High
7. Reliance on captive power	Low	Low	Moderate	High
8. Constraints on flexibility in dispatch	Low	High	Moderate	Moderate
9. Dominance by state-owned vertically-integrated utilities	Low with some exceptions	High	High	High
10. Reliance on central planning in the electricity sector	Low with some exceptions	High	High	High
11. Divergence from commercial orientation	Low	Moderate	Moderate	High
12. Political difficulty of reform	Mixed	Moderate	N/A (Just starting)	High
More general characteristics				
1. Distortions in factor markets (as indicated by degree of financial repression)	Low	High	High	Moderate
2. Degree of difficulty to find instruments to compensate low-income households for price changes	Low	Moderate	Moderate	Moderate
3. Institutional weaknesses relating to quality of regulation, levels of government effectiveness, and absence of corruption	Low	Moderate	Moderate	High

2.4 Choices: Mitigation Policies for Developing Economies

20. ***Given the climate change mitigation and related policy objectives of developing economies, the instruments available and economy conditions, what policy choices should they make?*** The question is an ambitious one, and the aim in this section is only to derive some tentative conclusions and point in some new directions. The report considers first carbon pricing (its desirability, its feasibility, and its importance relative to energy sector and broader reforms), and then technology-based policies.

21. ***The first conclusion is that carbon pricing may be desirable for developing economies with emissions reduction targets, but should be accompanied by measures to reduce reliance on traditional***

energy sources, or to prevent substitution from coal to oil. Carbon pricing, if effective, would help achieve emissions reduction targets, and would raise revenue in a progressive manner. Increasing electricity prices could have adverse consequences for removing households from the traditional energy sector, and these need to be managed. Direct measures to reduce the harmful impacts of biomass reliance will in any event be most important. Carbon pricing could also lead to substitution from coal to oil with potential adverse effects on the trade balance and on energy price volatility. To mitigate this, other measures are needed. For example, higher taxes could be imposed on oil or incentives given to encourage substitution from coal into nuclear or renewables.

22. ***Carbon pricing might be desirable (with the above qualifications), but would it work? Feasibility needs to be assessed from both political and economic perspectives.*** Several economies have shown, even with limited instruments, compensation packages can be put together, and this will ease one political hurdle carbon pricing faces. A more serious limitation is the failure of most developed economies to introduce carbon prices, which means that any carbon prices, if introduced into developing economies, are likely to be on the low side, as current discussions confirm. That said, it is important to take a longer-term perspective. Climate change is unlikely to go away as an issue. Over time, as climate change becomes more evident, more economies will act, and this political constraint will weaken.

23. ***From an economic perspective, some features of the energy sector into which a carbon price in a developing economy is likely to be introduced may limit their impact.*** This would be particularly true for those important segments of the energy sector which are regulated (typically, electricity and liquid fossil fuels but not, perhaps, industrial consumption of coal). For example, there is often limited flexibility in the electricity sector to change the fuel mix in the short-term, both due to shortages and other dispatch constraints. Moreover, given the dominance of central planning in the electricity sector in developing economies, an explicit carbon price may have little impact on the decisions of planners which are increasingly already trying to diversify away from coal.

24. ***The main risk here is that, given the political control exercised over energy prices in most developing economies, carbon prices, at least if they are high or rising, may not be passed through***. The recent spike in energy prices shows the limited extent to which many developing economies are willing to let energy inputs pass through to the consumer**.** The analysis suggests that in China, for example, electricity prices fell in real terms in recent years even as the market price of coal more than doubled. If governments are likewise unwilling (or in some economies simply unable – in Indonesia, the Parliament has to approve tariff increases) to allow carbon prices to be passed through to final users, this will clearly limit their ability to signal to consumers to make more efficient (or simply less) use of energy. More importantly, the prospect of limited cost pass through will limit the credibility of any introduced carbon prices and thus their ability to influence investment decisions. If utilities are not confident of being compensated in the market for making cleaner energy investments, experience suggests that they will limit such investments, even if they are mandated by a central planner. (Note that promises of compensation through the budget, that is, the government effectively paying the carbon price will not typically be credible.)

25. ***These important limitations notwithstanding, the introduction of carbon pricing could, nevertheless, still be a useful measure as part of a broader mitigation program***. Carbon pricing could have a powerful impact on the unregulated segments of the energy sector. In any case, no developing economy is contemplating making carbon pricing the central plank of its mitigation policy. They are approaching it much more in an experimental mode. The argument presented here should not be misinterpreted as being against carbon pricing. Rather it is to caution against unrealistic expectations and to emphasize the importance for mitigation of a broad-based response. Carbon pricing on its own will not suffice. Energy sector reforms, broader economic reforms, and technology based policies can also be important.

26. ***With respect to the energy sector, the need for subsidy removal has been the main focus of attention when considering broader sector reforms***. The G20 in September 2009 agreed to eliminate fossil-fuel subsidies over the medium-term. More important from the perspective of enabling carbon pricing to have an impact, but even more difficult to put in place, are policies to allow for cost pass-through – so that subsidies do not re-appear, and so that carbon prices can be passed on. While carbon pricing will not be fully effective without energy sector reform, it is also important to recognize that the impact of such reforms on their own could be to increase rather than reduce emissions, and depends on the economy context, sector, and type of subsidy being used. For example, if subsidies are reduced in a context of energy shortages, it is possible that energy use and emissions will rise rather than fall. This is not just a theoretical possibility, but supported by historical example. China removed its electricity subsidies by 2000, and the higher revenue financed the expansion of electricity supply, with most electricity production using fossil fuels.

27. ***With regard to broader reforms, the report focuses on the case of China and the need for financial sector, land and social security reforms.*** These reforms would probably make China's growth not necessarily less rapid but less capital and therefore less energy intensive. Ultimately, successful mitigation will require the de-carbonization of the energy sector. At that stage, whether growth is energy-intensive or not will have little influence on total emissions. Until that time, in some developing economies, broader economic reforms will have an important role to play in any mitigation strategy.

28. ***Technology-based policies are inevitable given the policy mix prevailing in many economies.*** Developing economies want to promote clean energy, not only or even primarily to reduce emissions but also to reduce air pollution, promote energy security and gain technological advantage. Policies which specifically target particular technologies are therefore an inevitable part of the mix. However, it is more difficult to determine the best policies to achieve clean energy targets. The evidence is both mixed and limited. This report emphasizes the need for more R&D funding, notes that there might be a case for government-provision of finance and guarantees, stresses the virtue of simplicity and caution in this complex field. It also notes the difficulties which an unreformed energy sector might pose for carbon pricing can also apply to technology-based policies.

29. ***The relative importance of these four reform fields – carbon pricing, technology-based policies, energy sector reforms, and broader reforms – is a matter for judgment, and will vary from economy to economy, and over time.*** Sequencing is an even more difficult issue. Which should be introduced first: a price on carbon, or the mechanisms to allow that price to be passed through? There is no clear and certainly no universal answer to that question. Where an economy chooses to move first will depend on political judgment as much as on economic analysis.

30. ***There are high uncertainties around mitigation.*** In developed economies, the main uncertainties around mitigation are political (will carbon pricing be introduced, and when) and cost. In developing economies, uncertainty also attends to both the implementation of reforms (for example, will energy sector reforms, even if announced, by carried through), and their impact (for example, how much will carbon pricing change the emissions intensity of an economy). There is little cross-country experience, but major risks, as outlined above.

31. ***Given the uncertainties, a quantity anchor for climate change fiscal policy is recommended***. The uncertainty around the impact of a carbon price, whether fixed by government or determined by the market, makes a strong case for thinking of carbon prices as instruments to achieve explicitly-stated environmental outcomes. The multiple fronts on which governments may need to move for an effective mitigation response – carbon pricing, technology-based policies, energy sector reforms, and broader

economic reforms – also make the case for an underlying quantity target, since it will make it easier for economies to judge progress, and adjust the policy mix accordingly.[5]

32. ***Developing economies have started to put quantity targets in place, but most have some way to go***. All of the economies submitting domestic commitments to the Copenhagen Accord have nominated quantity rather than price targets. It must be noted, however, that of the APEC non-OECD economies, only Russia and China have submitted targets which are verifiable. The majority of developing economies have submitted targets relative to business as usual (BAU) which is, by definition, only observable if there is no mitigation. If economies want a yardstick to judge their mitigation progress, they should convert their BAU targets into absolute emissions or emissions-intensity targets.

33. ***While the focus of the report is on CO_2 from the energy sector, several of the key issues which have emerged from the discussion are also important for other sources and types of greenhouse gases***. Box 2.1 illustrates with a discussion of forestry sector mitigation issues.

Box 2.1: Reducing Emissions from Deforestation and Degradation

The global importance of reducing emissions from deforestation and forest degradation has been stressed in recent years. Given the size of these emissions, they are simply too large to ignore. The IPCC's Fourth Assessment Report puts emissions from deforestation and related sources at about 17 percent of total global emissions (IPCC, 2007). The costs of reducing LUCF emissions are thought to be on average very low. An influential study carried out for the Stern Review (Grieg-Gran, 2006) examined the cost of reducing emissions from deforestation for eight economies that together are responsible for 70 percent of land-use emissions. The study finds that "If all deforestation in these economies were to cease, the opportunity cost would amount to around $5-10 billion annually (approximately $1-2/t$CO_2$ on average)" (Stern, 2007). The general message that "forestry can make a very significant contribution to a low-cost global mitigation portfolio" is one endorsed by the latest IPCC Fourth Assessment Report on the basis of its survey of forestry-related cost studies (IPCC, 2007) which found that 60 percent of all economic potential for avoiding deforestation would carry costs below $20/t$CO_2$.

But, as Howes (2009) argues, even if reducing emissions from deforestation and forest degradation is cheap, that doesn't mean that it will be easy. Howes points in particular to two problems which will face many developing economies. (This in the context of a study of Papua New Guinea, but they are easily generalizable.)

First, monitoring of forestry emissions is difficult. Grainger (2008) comments that "while the planet has been monitored by remote-sensing satellites since 1972, estimates of the annual deforestation rate are still inaccurate, and the appearance of each new estimate generates debate."

Second, governments might have few handles to respond to the drivers of deforestation, which can include subsistence agriculture and illegal logging. Forestry, which by definition occurs in remote locations, is a difficult activity to monitor. PNG would not be the only country where observers perceive a "lack of effective governance" in the logging business (Shearman et al., 2008).

In the energy sector, emissions monitoring is much easier, but, as discussed at length, there is a similar problem of finding an appropriate policy handle for reducing emissions. In general, the key mitigation issue for many developing economies will not be the cost of mitigation but the choice of instruments. There is no magic bullet, and much experimentation will be needed.

[5] An input or policy based process is good if it is easy to judge policy progress, but where multidimensional policy progress is required, this approach loses its transparency and simplicity and therefore its attractiveness.

2.5 Fiscal Aspects of Adaptation to Climate Change

34. ***Adaptation is the deliberate effort to obviate or ameliorate the bio-physical effects of a changing climate***. Adaptation to climate change necessarily occurs in the context of ongoing competition for a limited set of a society's resources. Choices need to be made between different adaptation projects, and between adaptation projects and other socially desirable investments such as education. Fiscal policy therefore has an essential role to play. The study of the fiscal dimensions of adaptation, however, is in its infancy. The main focus of this report is on the decision-making tools which economies will need in order to make efficient decisions about adaptation, and the instruments that they might have at their disposal.

35. ***The fiscal approach to adaptation which has received most prominence to date is its costing***. A range of studies have been produced by the United Nations and the World Bank. While these reports contain a wealth of useful information at the sectoral level, the utility of calculating aggregate costs at the national or global level is questionable. Apart from all the empirical difficulties of estimating a variety of locally-incurred costs, the fundamental conceptual problem is that costing adaptation to future climate change requires an ability to specify a counterfactual baseline that excludes expenditure devoted purely to economic development. There appears to be no satisfactory method of distinguishing adaptation measures from those intended to foster economic development. In any case, costs alone provide no rational basis for policy action. Comparison of both the costs of implementation of adaptation measures and benefits is required if welfare is to be maximized.

36. ***Adaptation instruments are also starting to receive more attention***. The report stresses the provision of public goods and public sector pricing reforms as key fiscal reforms to support adaptation. Water pricing reform in particular will be essential for successful adaptation. There is a clear parallel to the importance for mitigation of pricing reform in the energy sector. The report also canvasses the use of financial instruments, such as microfinance and insurance. Getting credit and insurance to households in the rural sector is a challenge for all developing economies, but, if feasible, they can be effective alternatives to the provision of subsidies to help households adapt.

37. ***The main focus of the report, however, is on decision-making tools.*** As climate change and awareness of climate change grows, Finance Ministries can expect to be increasingly confronted with requests for funding and possibly for fiscal reforms, such as changes in taxes, subsidies, and prices. How are fiscal decisions about adaptation to be made? Four popular decision rules are:

- The purpose of *Multi-Criteria Analysis* is to assess the relative contribution of a selected group of impacts or attributes to the achievement of an overall objective or goal. Apart from the arbitrary nature of selecting attributes and assigning scores and weights, the process is fundamentally flawed mathematically. As various commentators have noted, it is equivalent to adding apples and oranges.
- Vulnerability, adaptive capacity and resilience indexes are increasingly calculated in relation to climate change, and often used for policy purposes. However, such indices suffer from several of the same methodological weaknesses as Multi-Criteria Analysis, and provide no clear decision rules when considering potential adaptation measures.
- *Cost-Effectiveness Analysis* is used in everyday life, and is easily presented to and understood by policy makers. A measure of technical efficiency, it expresses a result in terms of the cost of achieving it. For example, the number of lives saved for the cost of each kilometer of a 5 meter dike constructed. At its most simple, it can reveal projects that generate the 'biggest bang for the buck.' However, this is also its limitation. Comparisons can only be made between projects of a very similar nature.

- *Cost-Benefit Analysis (CBA)* has a number of well-known drawbacks. It generally requires monetization of both costs and benefits, assumes that the marginal utility of money is equal for everyone (unless distributional weights are used), and it is expensive to conduct. Nevertheless, CBA remains the only rigorous analytical tool available in terms of assessing issues such as the relative merits of different adaptation projects and strategies. In particular, it affords policy makers an unambiguous decision tool in requiring that the net present value of benefits to society as a whole exceed the net present value of costs incurred. In other words, of all the analytical tools available, it alone permits not only comparison of adaptation measures with each other, but also with alternatives (e.g. education, health spending) that are not necessarily associated with climate change effects.

38. ***This report illustrates the importance of cost-benefit analysis (CBA) with the example of dikes in Vietnam***. The Mekong delta is currently experiencing a rapid growth in the construction of high dikes. However, the reported cost-benefit analysis suggests that in fact Vietnamese farmers would be better served by building temporary dikes to protect the (second) summer rice crop from floods in August each year, with the option of allowing floodwaters into the paddy field afterwards for fertilization with river silt and to undertake flood-based farming activities.

39. ***A key advantage of CBA is that it is possible to incorporate uncertainty about climate change impacts.*** Uncertainty is in many ways the hallmark of climate change. Knowledge is lacking – particularly at the local level – as to both the intensity and the timing of future climate change. Much work on adaptation has been based on mean values, but adaptation, by its very nature, requires consideration of extremes. The intensity of future weather events might remain much as it is today, or change along a spectrum that includes both the benign and the catastrophic. The timing of any additional intensity is equally uncertain.

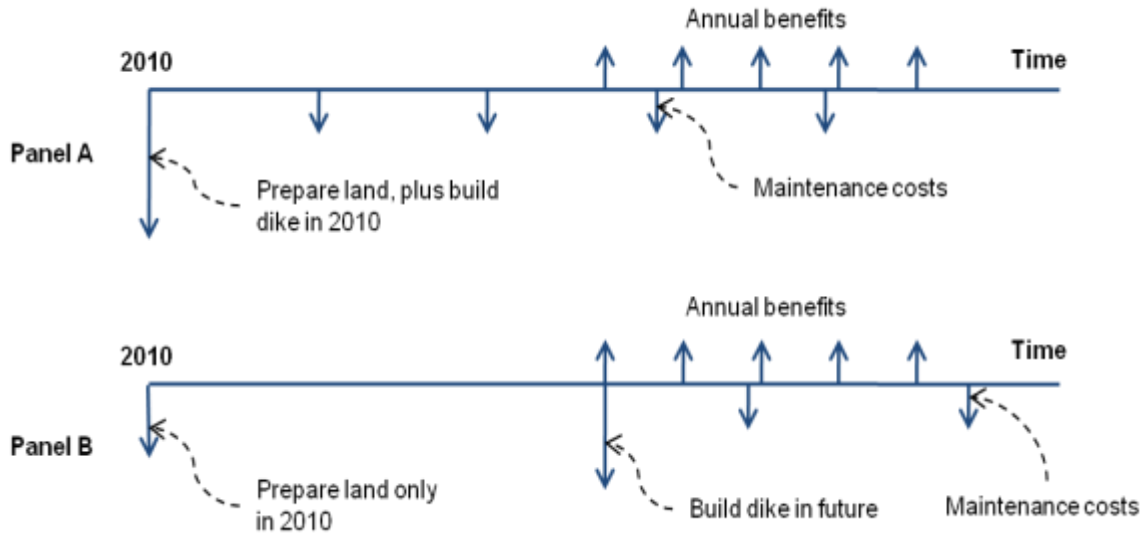
40. ***In fact a particular advantage of the cost-benefit framework is that it allows for the incorporation of uncertainty.*** The report canvases two methods. Monte Carlo analysis permits probabilistic modeling of estimated net present values, taking into account probabilities associated with climate change and other variables. The 'real options' approach discussed below is also readily assimilated within the cost-benefit framework.

41. ***Most economies have sufficient historical data to generate models based on extreme value distributions***. Probability distributions which reflect historical experience can be 'augmented' or shifted to take into account future climate change over the coming century on the basis of predictions obtained from physical climate models. Further, to reflect the uncertainties involved, a series of distributions can be generated for each year or period under examination. By then applying a damage function to each of the 'augmented' probability distributions for each year between 2010 and 2100, a set of cost functions can be generated for each year. Applying Monte Carlo analysis by generating random numbers to choose flood heights (from among the different distributions), a probability distribution of costs can then be generated for each year, giving a range of possible values of cost for each year, rather than single point estimates. This approach was applied in cost-benefit work commissioned by the Australian Department of Climate Change and Energy Efficiency (2010).

42. ***The 'real options' approach is useful not only for assisting decision-makers to cope with uncertainty within a cost-benefit framework, but also to encourage planners to incorporate options into the design of adaptation projects***. The flexibility incorporated into real options, coupled with the delay of full investment, can expand the number of potentially viable projects. The flexibility of real options is particularly advantageous for seriously budget-constrained governments. Expenditure on climate-relevant projects can be spread out over time. This aspect makes 'real options' analogous to a 'just-in-time' technology. Because budgets can be spread out more efficiently over time, a greater number and a greater range of climate-relevant projects can be funded.

43. ***Options are typically thought of in relation to financial assets but they can also be identified, or developed, for physical (real) assets***. Panels A and B of Figure 2.2 below provide an overview of a 'real options' approach, again using dikes as an illustration. In this case, the decision is whether and when to construct a dike intended to prevent future inundation resulting from more intense or more frequent floods due to climate change.

Figure 2.2: Two Different Approaches to Building a Dike to Respond to Increased Flooding Risk



44. ***It is, of course, possible to build a dike immediately (along the lines of the popular 'precautionary principle').*** Panel A illustrates this case. The full cost of construction is incurred immediately, with regular maintenance costs thereafter, but the benefits are realized only at some uncertain time in the future.

45. ***The alternative shown in panel B is to expend only a relatively small amount today on surveying or preparing the land on which a future dike could be built.*** This amount – smaller than the full cost of a dike – is analogous to the price paid to acquire a financial option, because it establishes the opportunity, but not an obligation, to invest in the full asset when required. A full investment can be made when the benefits of countering the effects of climate change increase the value of the asset above its costs. The net present value of the panel B approach is higher than that in panel A, irrespective of the discount rate used.

46. ***The key difference between the two approaches is that panel B incorporates flexibility***. As time goes by, it may be found that climate change is occurring slower than originally anticipated, perhaps due to reduced global emissions. By waiting until better information becomes available, a dike can be built with a height more closely matched to the actual climate of the future. The greater the uncertainty, the more valuable is the flexibility associated with being able to wait for better information. Because the community's resources are used more efficiently, a greater number of adaptation projects (or even general developmental projects) can be initiated out of a given budget.

47. ***The 'real options' framework can be readily incorporated into a social cost-benefit framework.*** While uncertainty about climate change precludes specification of actual dates when benefits from a dike will begin to flow. The application of Monte Carlo analysis to the results of climate modeling can provide some guidance to the analyst in the form of a predicted optimal construction date, which can be updated with new information over time, as long as the analysis accepts that the future predicted by a suite of climate models and/or projections is approximate.

48. ***Options can be built into many sorts of projects, private and public***. Encouragingly, it is found that Vietnamese authorities are already starting to take a real options approach to the heightening of dikes. In the Cho Moi district of An Giang Province in Vietnam, commune authorities have located electricity power lines away from the existing dike, and have banned planting of trees next to the existing dike. These measures will ensure quick exercise of the option of increasing the height of the dike, once a decision has been taken on timing of implementation. In some other economies, options have and can be applied to a range of water and infrastructure projects, which are relevant to adaptation.

49. ***However, applying the real options approach requires innovation.*** It demands a good degree of creative thought, and a willingness to move away from seemingly risk-averse deterministic solutions, even though such projects, executed without delay, are better suited to established budgetary precepts and are more closely aligned with current project management practices.

3. TRADE AND INVESTMENT POLICIES TO PROMOTE CLIMATE FRIENDLY TECHNOLOGIES IN APEC

3.1 Introduction

1. ***Climate friendly technologies (CFT) reduce the emissions of greenhouse gases (GHG) by reducing the carbon content of economic activity***. Climate change, created by greenhouse gases, is expected to affect many sectors, and present risks to many middle-income APEC economies in Asia. These risks include falling freshwater availability, rainfall volatility, frequent hurricanes and droughts, and a greater risk of coastal flooding. All these will cause significant negative impacts on APEC member economies. Given that APEC economies account for more than half of global GHG emissions, the adoption of emissions reducing CFTs in this region is critically important for the global emissions mitigation agenda.

2. ***This chapter, first, describes the wide range of different CFTs already in use in middle-income APEC economies and their potential***. As such, it is a fairly comprehensive reference on CFTs that are used and produced in middle-income APEC economies, and on the factors including domestic FDI legislation and energy security policies – that have contributed to their uptake thus far. The regional reviews and analyses are coupled with country level analyses of China, Indonesia, Thailand, and Vietnam.

3. ***Second, it discusses the potential for further use and production of CFTs in APEC economies and the challenges facing their adoption***. Several APEC economies are emerging as leaders in producing CFTs for domestic use as well as for trade, consistent with their ambitious energy efficiency and GHG reduction targets. The study discusses issues facing further CFT uptake, and how these could be addressed through trade and investments in CFTs. The report notes that achieving this potential will require removing an array of impediments through trade and investment policy reforms, which are identified in this study.

4. ***Third, it attempts to identify CFTs that have the most potential for further use***. For example, this report identifies wind power technologies in Thailand as one of two CFTs with the most potential for further expansion of installed capacity and that may benefit the most from targeted trade and investment policies. The report, however, also makes the case that there is currently insufficient information to design a cost-effective wind power promotion policy. By providing estimates of possible investment requirements, estimating potential CO_2 equivalent emissions reductions, and by describing current policy impediments, this study provides a strong foundation upon which to conduct further investigations for well-designed CFT promotion policies.

5. ***Finally, the report addresses issues concerning the design of effective technology-based policies that support economic development through the adoption of CFTs***. In sum, this will, first, require a substantial mobilization of international investments in CFTs. An additional USD 200 billion annually by 2030 is the estimated level of investment required to return GHG emissions to current levels. The United Nations Framework Convention on Climate Change (UNFCCC) estimates that a higher percentage of international investment to reduce GHG emissions will need to be directed towards the adoption of CFTs in developing and middle-income economies. Second, it will require trade policies that facilitate transfer of CFTs across borders. This chapter identifies a range of tariff and non-tariff barriers that currently impede this.

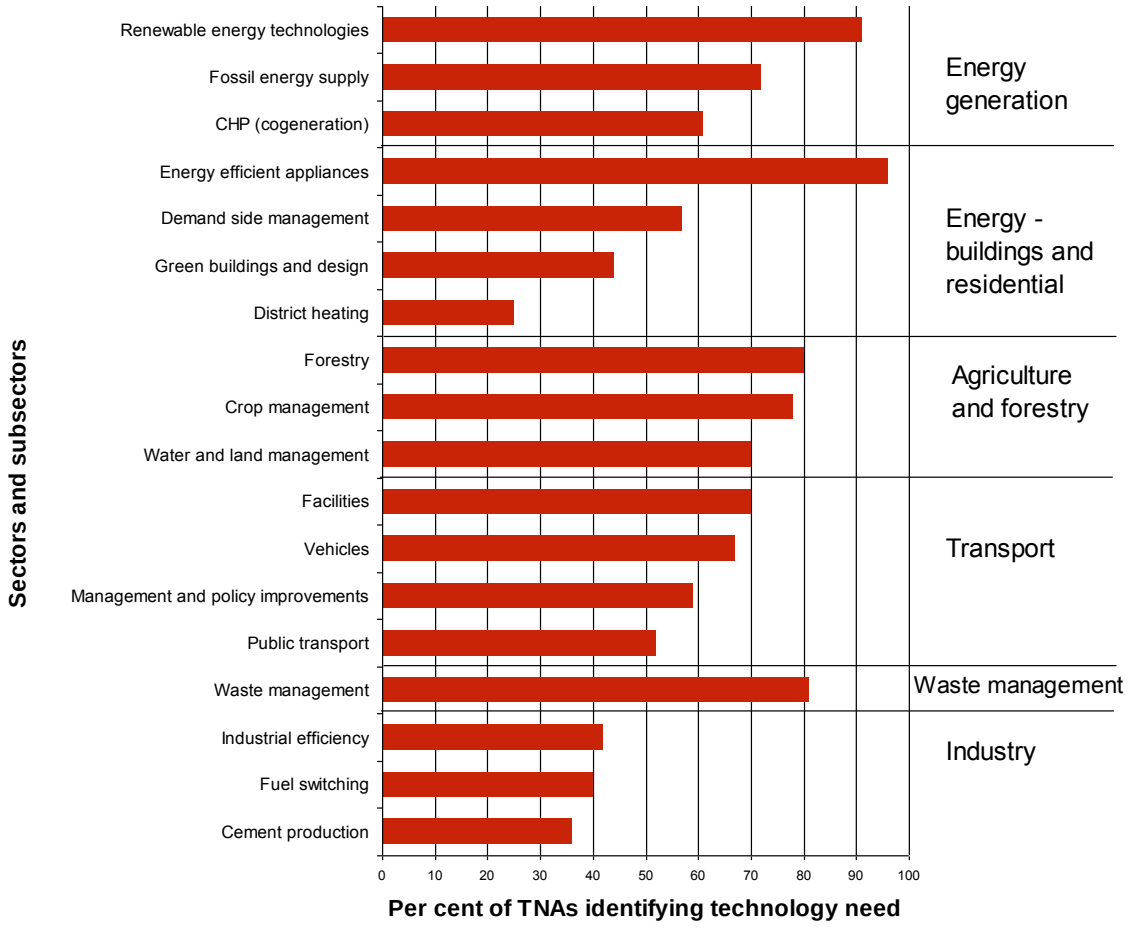
3.2 Climate Friendly Technologies in APEC Economies

6. ***A diverse range of CFTs are used in APEC economies***. These technologies, at various stages of development, range from large-scale to micro-scale (household level), and relatively generic technologies to sector-specific technologies. Energy is the most important for reducing GHG emissions, as shown in the UNFCCC's Technological Needs Assessments (TNAs), and technologies targeting end-use efficiency and energy conservation represent some of the most cost efficient and important demand-side options (Figure 3.1). Advanced fossil fuel power generation and alternative energy sources are also technologies that have large mitigation potential. The study of emission abatement costs of these technologies shows that cost-effective emissions reduction strategies must include a combination of technologies.

7. ***There are four major sets of large-scale generic technologies: (i) energy efficiency and conservation improving; (ii) advanced fossil-fuel; (iii) renewable energy technologies; and (iv) carbon capture and storage (Figure 3.1, next page).*** The first set includes technologies in building design improvements, combined heat and power (CHP) generation, efficient lighting systems, and automobiles. The majority of savings in energy efficiency in buildings can be achieved through the use of widely accessible mature technologies in building design. The IPCC (AR4) reported that there is international evidence suggesting up to 29 percent of baseline 2020 emissions in the residential and commercial building sectors could be reduced cost effectively. Combined heat and power (CHP) generation (or cogeneration) increases the efficiency of power and heat generation facilities. The IEA further estimates that if the most efficient forms of lighting currently available were implemented globally, such as compact fluorescent lights (CFLs), electricity consumption in lighting could be almost halved by 2030. Strong advances in fuel efficiency technology and alternate fuels are thus required to achieve significant reductions in this rate of growth of emissions from automobiles, and to reduce the current dependence on petroleum fuels (IPCC, 2007). The hybrid electric engine has the ability to reduce GHG emissions by between 30-50 percent compared to petrol, and without a reduction in power or safety performance (Romm, 2006).

8. ***The second set includes advanced fossil fuel based electricity technologies that can significantly reduce emissions intensities.*** About 41 percent of global electricity is generated by coal or peat and an additional 5.8 percent by oil. Advances in reducing the emissions intensity of fossil fuel based power stations are being led by the development of natural gas combined cycle (NGCC) or integrated gasification combined cycle (IGCC) power plants. The key advantage of IGCC power plants is their relatively high energy efficiency potential. This efficiency is currently approximately 50 percent; as with NGCC, this is expected to improve. In addition, the high concentration of carbon dioxide in the flue gas offers potential for efficient carbon capture and storage. Currently there are six commercially operating IGCC plants: two in the United States, three in Europe, and one in Japan. These stations have a combined installed capacity of 1,700MW (EPRI, 2008).

Figure 3.1: Mitigation Technologies, by Sector, Identified in TNAs



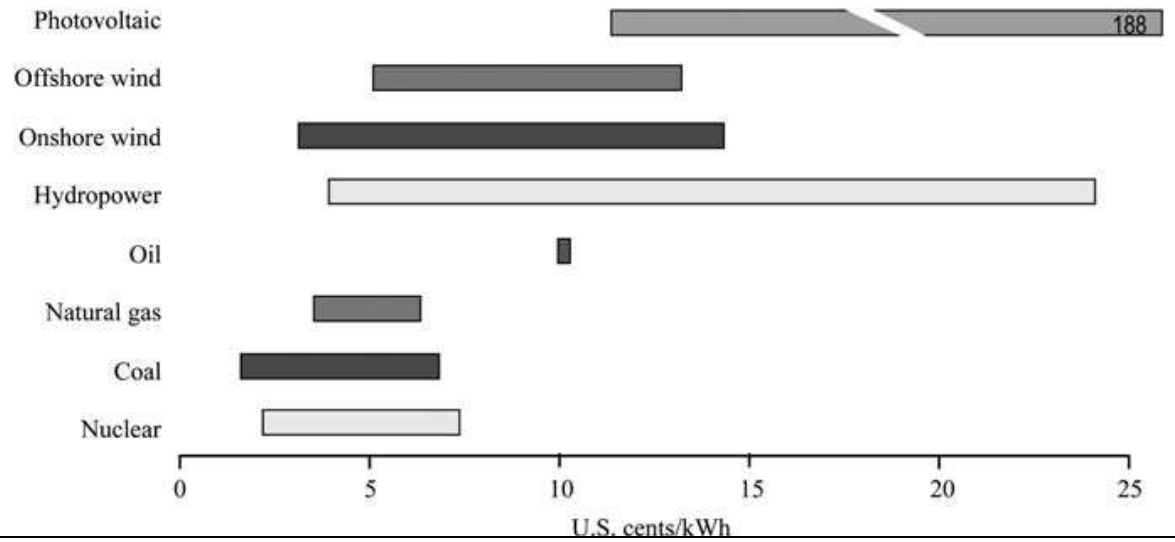
Source: UNFCCC (2009)

9. ***The third set of major CFTs that needs to be a part of a comprehensive mitigation strategy is renewable energy technologies***. Renewable energy technologies have substantially lower emission intensities than coal-based technologies. However, their generally higher current investment costs have so far inhibited their uptake. Figure 3.2 (next page) illustrates the costs associated with the new construction for various electricity generation technologies. It shows that while traditional electricity generation technologies, such as coal and nuclear based generation, generally have lower costs than up and coming technologies, the costs of the new technologies at the lower end can be competitive vis-a-vis traditional technologies. Despite the high costs, governments continue to support renewable energy technologies because they recognize that such technologies are maturing and have many other benefits (like lower emissions). Major renewable energy CFTs in Asian APEC economies include hydro-electric power, wind power, bio-fuels (including biomass), and photovoltaic solar power.

10. ***The fourth technology is carbon capture and sequestration which has been tested to be technically feasible and, if viable, can have a large impact in reducing emissions in a cost effective way.*** If it becomes viable at the scale needed it would provide an option for future abatement of carbon dioxide emissions, while still allowing coal based electricity generation. The power generation sector is the most promising sector for the implementation of CCS technology. The IEA estimates that between

52-89 percent of CO_2 emissions captured will be from the electricity generation sector from 2020-2040. In addition, by 2030, up to 22 percent of global electricity is projected to be generated from fossil fuel based power plants fitted with CCS technology; this penetration rate is projected to increase to approximately 40 percent by 2050 (Gielen, 2003). CCS technology is expected to become commercially viable over the next 10-15 years despite currently limited plant-scale experience. Its viability will, however, rely on the introduction of carbon prices in the range of USD 25-30 t/CO_2 (IPCC, 2005).

Figure 3.2: Costs Associated With New Construction for Different Electricity Generation Technologies (US cents kWh)



Note: The costs are "normalized", equal to the constant dollar price of electricity that would be required over the life of the plant to cover all operating expenses, interest and repayment obligations on project debt, and taxes plus an acceptable return to equity investors over the economic life of the project.
Source: Kessides (2010)

11. ***Hydro-electric power already accounts for significant shares of total power generation, and has the potential for further development (Table 3.1***). The world's largest producer of hydroelectricity is China, representing almost 14 percent of global installed capacity, and producing 478 TWh of hydroelectricity (World Energy Council, 2008). The ASEAN-10 also has 16,110 MW of installed hydro power, representing more than three-quarters of their total installed capacity in renewable energy (Table 3.2).

Table 3.1: Potential for Climate Friendly Technologies in Middle-Income APEC Economies

	China	Indonesia	Thailand	Vietnam
Wind (installed capacity)	25.1GW	0.5-1MW	0.7MW	62.5MW +
Hydroelectric (installed capacity)	694GW	9.5 GWh *	n/a	200MW
Biofuels (billion litres)				
Ethanol	3,550	170	383	80
Biodiesel	35	590	35	0
Solar (installed capacity)	140MW	12MW	7.5MW +	2.25MW
Cogeneration (installed capacity)	80GW	1.2GW	2MW	0.3MW +
Household biogas plant (units)	22 million	6,000	n/a	73,000
Landfill gas (production)	14GWh	n/a	n/a	n/a

Notes: + minimum estimate, as this refers only to known projects, * installed capacity is not known
Source: World Bank (2010d)

Table 3.2: Renewable Energy Status for Power Generation in South East Asia (2000)

Country	Biomass	Geo-thermal	Hydro	Mini micro-hydro	Solar	Wind	Total (MW)
Brunei D.	-	-	-	-	0.0024	-	0.0024
Cambodia	n.d.	-	18	0.96	1.13	-	19.09
Indonesia	302	363	4.246	21	8	0.4	4,940.40
Lao PDR	n.d	-	621	6	0.16	-	627.16
Malaysia	213	-	2,225	6	2.19	0.15	2,446.34
Myanmar	-	-	340	83	0.24	-	423.24
Philippines	21	1,960	2,480	230	0.44	0.016	4,691.50
Singapore	220	-	-	-	-	-	220
Thailand	1,230	0.3	2,886	94	8	0.17	4,218.47
Vietnam	n.d	-	3,294	62	0.11	0.15	3,356.26
ASEAN-10	1,986	2,323.30	16,110	502.95	19.27	0.93	20,942.46

Source: World Bank (2010d)

12. ***Wind energy CFTs follow hydro-electricity in power-generation***. The development and installation of wind turbines of up to 750kW in size is considered to be a mature commercial industry in China. The country has doubled its wind power installations for four straight years and is on track to become the world's second largest wind energy producer by 2010 (Li et al., 2007). China has approximately 20 domestic manufacturers, and was the seventh largest exporter of wind energy technology in 2008. Wind power in Indonesia and Vietnam also has the potential to provide cost-efficient energy to remote and rural areas. Installed wind power capacity in Indonesia is around 0.5MW to 1MW. Wind power generation is predominantly located in eastern regions of Indonesia and used for powering water pumping stations and recharging batteries. In Vietnam, wind power has been considered for use in

island and rural areas since the 1980s but only accounts for a very small proportion of domestic power generation. The technical capacity for wind power in Vietnam is approximately 1,780MW.

13. ***Middle-income APEC economies are major producers of biofuels***. In 2005, China was the third largest global producer of biofuels after Brazil and the USA (USDA, 2006). Indonesia is currently the world's largest producer of crude palm oil (APEC Energy Working Group, 2008b). Thailand is the world's third largest producer of biodiesel, with the predominant feed stock of palm oil. The biofuels market in Vietnam is currently in the early stage of development, but with vast resources of biomass, the government has announced goals of up to 500 million liters of production of fuel ethanol by 2020, and 50 million liters of biodiesel. Biomass power accounted for around 9 percent of total power generation in the ASEAN-10 in 2000. Biomass biofuels can be competitive with coal based generation. If feedstock can be supplied at low or zero cost, then electricity can be generated for as little as $20/MWh. However, at present, power from biomass gasification on average generates electricity at around twice the cost of most fossil fuel based power generation plant, constraining its expansion.

14. ***Solar photovoltaic (PV) electricity systems are not only major contributors of installed capacity but can also provide valuable off-grid power***. Indonesia is characterized by a large number of small and highly dispersed communities, and PV solar technology is currently mainly used to supply households that are not connected to the grid. Overall, around 12 MW of PV capacity has been installed, corresponding to around 100,000 solar home systems (SHS) for purposes such as lighting, television, communication, battery charging and refrigeration. On current plans, another 30,000 systems will be installed in Indonesian households. The application of photovoltaic (PV) solar technology in China is also set to change rapidly. China is already the world's largest producer of PV cells, a large proportion of which are exported. Installed PV solar capacity expanded significantly between 2007 and 2008, from 100MW to 140MW (UNEP, 2009).

3.3 Current Investment Policies to Promote CFTs

15. ***Middle-income, emerging and developing APEC economies are well placed to take advantage of CFTs available through international trade and investment***. With the international community facilitating discussions about the use of CFTs and promoting investment in CFTs, developing economies have the potential to use this momentum, facilitating international and domestic investment to promote development and increase their presence in the market for these technologies. Strengthening trade and foreign investment requires the existence of a transparent and consistent overarching policy framework.

16. ***Financing investment for CFTs, however, is a key policy challenge and four main channels for financing CFTs have been used in APEC economies. First,*** Kyoto Protocol's Clean Development Mechanism (CDM) permits industrialized economies to invest in ventures that reduce emissions in developing economies. CDM represents an effective mechanism to enable the transfer, diffusion and adoption of CFTs. The importance of technology types encouraged by the CDM varies by country. Of China's 579 CDM projects, 275 are in hydroelectric power and 127 in wind power generation projects. Indonesia has 24 CDM projects of among which there are 8 biomass and 6 methane avoidance projects. Similarly, biomass and methane avoidance projects account for 16 of Thailand's 18 CDM projects. Vietnam has one CDM project each for fugitive emissions, landfill gas usage, reforestation, and wind power, and two hydropower CDM projects.

17. ***Second, public investment and subsidy programs in CFTs have played a leading role, highlighting the gap between their costs and other alternatives that can attract investment in the market***. China has committed large amounts of resources toward the development of renewable energy. By 2020, the Chinese government will commit approximately USD 125 billion into further development of hydropower facilities, equaling the entire value of Chinese renewable energy projects in 2007 (APEC, 2009). In July 2009, the Chinese government announced a new subsidy program directed at utility scale operations and facilities. These facilities are required to generate at least 300 kW of peak capacity, be

operational within 12 months and have a minimum operational life span of 20 years. The Ministry of Finance has committed to subsidizing 50 percent of total investment in the solar power projects, as well as supporting transmission and distribution systems to connect to the grid. In remote regions not connected to the national grid, the subsidy is increased to 70 percent.

18. *The intense interest in commercial PV solar development in China illustrates the importance of public sector support*. The support for this sector includes the enactment of several policies like regional feed-in tariffs (FITs) and subsidies for solar PV installations. For instance, the Jiangsu government put in place an attractive FIT, which nearly covers project costs. The FIT has encouraged several leading PV manufacturers, including Suntech and Trina Solar, to oversee the development of 80MW and 30MW rooftop PV projects, respectively. By 2011, 400MW of PV capacity are scheduled to be completed in Jiangsu.

19. *Thailand also has a number of policy measures to support investment in CFTs.* Renewable and alternative sources of energy are given priority in terms of tax incentives and import duty exemptions. Thailand has attractive investment policies supporting CFT development, such as import duty reduction for machinery, corporate tax exemptions, import duty exemption on raw materials for manufacture of domestic and foreign sales, discount from transport, electricity and water costs and additional incentives for relocation of existing facilities to regional areas.

20. ***Third, the private sector plays a key role in the transfer of CFTs technology through investment, which is sometimes motivated by policy driven incentives***. Corporate R&D, venture capital, asset financing arrangements, and funds raised on public markets have been the main financing instruments. The 2009 World Economic Forum reports that total investment in clean energy increased from approximately USD 33 billion in 2004 to approximately USD 148 billion in 2007, then dropping slightly in 2008 to approximately USD 142 billion. Of this, USD 42.6 billion was invested directly into companies via venture capital, company based R&D funds, government research and development funds and public markets. This investment was used to finance equipment manufacturing and production up-scaling, as well as technology development. In terms of investment in specific technologies, wind, solar and biofuels technologies attracted the largest proportion of third party investment in 2008, with wind power accounting for almost half of capacity investment worldwide in 2008.

21. ***Fourth, FDI is an important channel for investment in CFTs. Vietnam's legislative framework thus provides tremendous support to FDI generally***. Recent legislation includes the Law on Technology Transfer (2006), Law on Investment (2005), Law on Enterprises (2005), Law on Intellectual Property (2005) and Law on Competition (2004). In addition, recent legislation is supportive of renewable energy projects. Relevant legislation supporting the development of renewable energy and rural electrification includes the Vietnam Power Sector Development Strategy (2004) and the National Energy Strategy Development (2007).

22. ***Given the current costs of CFTs, their financing and investment requires certainty about investment policies and incentives.*** For example, the Chinese government introduced the "Temporary Implementation Rules for Setting up Feed-in Tariffs for Renewable Energy Power and the Sharing of Expenses in Purchasing Electricity from Renewable Energy" in 2007. The intention of this policy was to share the additional charges for renewable energy nationwide, thus supporting utility development in provinces that are incapable of self-sufficient funding. However, Li et al. (2007) pointed out that policy also needed to provide more certainty around the time horizon of these incentives. This would have boosted confidence amongst potential investors, and thus increased the uptake of the incentives and the efficiency of the policy. Also, cross-border merger and acquisition activities in China have been curbed by legislations such as 'Regulations on the Acquisition of Domestic Enterprises by Foreign Investors'.

3.4 Current Trade Policies to Promote CFTs

23. ***International trade has become an important conduit for transferring CFTs in the APEC region, even from developing economies***. A review of global flows of established environmental technologies (EETs) shows that China is a major importer and exporter for integrated gasification coal cycle (IGCC), wind, solar photovoltaic (PV), and compact fluorescent light (CFL) technologies, and that Indonesia and Thailand are also major exporters of CFL technologies. Malaysia, Thailand and the Philippines are net exporters of component goods required to construct renewable/clean energy technologies, hydrogen peroxide, hydraulic turbines, water wheels and regulators, parts for hydraulic turbines, instantaneous gas water heaters, solar water heaters, wind-powered generating sets, and photosensitive semiconductor devices, including solar cells. China, the Republic of Korea, and Chinese Taipei are important exporters, primarily to other Asian economies, in the water and wastewater management sectors.

24. ***Future CFT transfers through trade will need to address two issues***. First, high tariffs on environmental-related technologies are a major barrier to the wider use of such technologies. Economies involved in the production of CFTs often impose an escalating tariff structure. That is, lower tariffs are imposed on parts and equipment used as input in the production CFTs, while higher tariffs are applied to complete CFT products. One example of this was China, where tariffs for wind turbines were 3 percent for individual parts, 8 percent for assembled components, and 17 percent for entire pre-assembled turbines.

25. *Eliminating tariffs alone would increase trade by around 7 percent from current levels.* Middle income APEC economies have many opportunities to take advantage of tariff liberalization. Average applied tariffs on CFTs in countries like China, Thailand, and Indonesia are currently higher than applied tariffs in developed economies (Table 3.3). Tariffs on CFTs also tend to be higher than average tariffs on other industrial products, as in the case of CFL tariffs in Thailand or wind power technology tariffs in Indonesia.

Table 3.3: Applied Average Tariffs for CFTs in Middle-Income APEC Economies

Economy	Clean coal	Solar	Wind	CFLs	Average industrial tariffs
China	15	8	10	8	10
Thailand	1	10	10	20	16
Indonesia	0	10	15	5	7
High-income OECD	1	3	3	4	4

Notes: No data available for Vietnam.
Source: World Bank (2008)

26. ***Second, non-tariff barriers (NTBs) or non-trade-related barriers would also need to be addressed for effective diffusion of CFT to take place***. Out of 105 CFTs, only about 32 products are affected by tariffs, NTBs are the major barrier to trade for most products. The World Bank estimates that the complete elimination of tariffs and non-tariff barriers (NTBs) would lead to an average increase of trade in clean coal technology, wind/solar power generation, and energy efficient lighting technology by 13.5 percent at the current level, with some variation across technologies and economies (World Bank, 2008).

27. ***Among NTBs, standards, certifications, subsidies and environmental regulations are major non-tariff barriers to trade in established environmental technologies***. Technical standards and

certification requirements, for instance, limit trade because products from developing economies face difficulties when entering the market of developed economies due to lack of appropriate standards for their products. For Asian economies, marketing restrictions, labeling, packing, documentation requirements, harassment of imports, distribution, logistics and banking restrictions are major barriers. The lack of technical capacity is another major barrier to CFT trade. In particular, the technological capacity building would be particularly effective in the solar energy sector and in the chemicals industry.

28. ***Many middle-income APEC economies have taken steps to facilitate international investment and trade in CFTs***. For example, Indonesia has introduced a number of reforms and incentives to increase the attractiveness of the country as an investment location, and has capitalized on international cooperative efforts. Investment in Indonesia is hampered by the range of restrictions to foreign investment that have been put in place.

3.5 Other Policy Impediments

29. ***A number of other policies currently in use middle-income APEC economies also pose impediments to reducing emissions***. Energy security policies promoting energy self reliance of an economy are potentially very costly for the economy concerned and/or for the environment. Trade related investment policies restricting investors tend to raise costs for investors and for consumers. Also, policies that facilitate energy consumption through the use of high cost energy subsidies, encourage wasteful behavior and risk broader economically distortionary outcomes.

30. ***There are several practical challenges to the expansion of CFTs, in addition to costs and financing***. These include problems related to legal and policy framework, planning and implementation, adequacy of inputs, and lack of information along with other institutional weaknesses such as quality assurance. The top part of Table 3.4 summarizes these challenges and offers recommendations for addressing them. The bottom part summarizes issues related to cost and financing and lists options for addressing them. Which of those options could be recommended depends on circumstances and requires further assessment before any broader conclusions can be drawn.

Table 3.4: Overview of Issues Arising in the Adoption of CFTs and Policy Recommendations

Issue	Recommendation
Inadequate Policy and Legal Framework	
Unclear specification of energy project	Targets should be defined in terms of useful capacity or output (rather than targets that can be circumvented)
Ineffective targets	Improve capability within government to set effective targets Improve monitoring of targets
Overlapping government agencies	Establish coordinating body to align policies
Unclear legal framework	Seek consultation with key stakeholders, including members of industries and foreign investors Improve tender and approval processes Combat corruption Encourage communications with investors
Lack of confidence in intellectual property rights	Create framework for patent registration and enforcement
Weak planning and implementation capacity	
Insufficient data on installed capacity and their	Structured inventory of capacity

Issue	Recommendation
effectiveness	
Mismatch between estimated/theoretical and actual capacity of energy from renewables	Formal resource assessment
Mismatch between geographical availability of CFT and local requirement	Coordinated national planning processes for rural/urban developments Consideration of decentralised/small scale technologies
Lack of grid connectivity to CFT	Consideration of off-grid small scale technologies
Insufficient support after installation	Require providers to offer complete package of services
Lack of technical expertise in installation and maintenance	Establish training programs for: - Industry and technicians; - Government staff; - Small private companies; - Community based providers; - Consumers
Challenges in Supplying CFT inputs	
Competition for CFT inputs (biofuels)	Introduction of specific CFT inputs, e.g. inedible biomass sources
Volatility of CFT inputs (wind, water)	Alternative (smaller scale) technologies Use of complementary technologies
Information and institutional challenges	
Lack of public information	Raise community awareness Improved education Create technical & training institutions
Complex institutional arrangements	Application of a more decentralised approach
Unreliable quality of CFTs	Create standards and specifications for CFTs
Reduced effectiveness of CFTs	Put in place longer term institutional/contractual arrangements
Cost and financing issues	**Potential Options**
High up-front costs of SHS	Limited use of targeted subsidies Use of microfinance institutions Use of commercial/development bans Examine quality standard required
Funding and project risks	Focus on small scale/pilot projects until technology is proven/established Create stable policy framework for investors
Funding difficulties for small/ start up ventures	Government-managed special funds Low interest loans Cooperation with commercial banks
Financing of energy efficiency measures	Targeted financing opportunities in cooperation with government Targeted financing mechanisms with third parties
Economic and pricing barriers	Undertake energy price reform Establish FITs to underwrite financial viability Fiscal incentives, such as tax exemption, depreciation

31. ***The following examples illustrate the challenges listed above. <u>First</u>, CFT promotion challenges can be exacerbated by inadequate legal and institutional arrangements***. For example, Thailand currently offers subsidies for the production of liquefied petroleum gas (LPG), but not for the production of biomass. This distortion makes it much more difficult for the unsubsidized biomass technologies – like the small scale biomass producer gas industry – to compete with the subsidized LPG sector.

32. ***<u>Second</u>, weak planning creates mismatches between capacity creation and their use, leading to wastage***. The Chinese wind sector illustrates this mismatch. Some reports indicate that up to 30 percent of wind assets are either not in use, or not connected to the national power grid. Also, wind power, representing 1.5 percent of installed electrical capacity, account for only 0.4 percent of generated electricity. Furthermore, the coastal areas have a large power load but less wind resources while the northern areas are richer in wind resources but have lower power load (Li et al., 2007). In order for companies to satisfy installed capacity specifications, some turbines have been opportunistically built in areas where there is no connection to the national power grid (Kwok, 2009).

33. ***<u>Third</u>, several other sectors are competing for critical CFT inputs raising their costs***. In the case of biofuels in China, Indonesia, Thailand and Vietnam, there is competition for biomass input from pharmaceutical, food and beverage industries. The risk is that biofuels expansion damages other industries, including food-producing industries. Crops used for food supply are the main competitors for biodiesel, with the potential for increased production of biodiesel-specific feed stocks putting increased pressure on food supplies.

34. ***<u>Fourth</u>, lack of technical capacity can severely limit CFT uptake. Indonesia and Thailand have faced this challenge in their plans to promote photovoltaic (PV) solar power***. In Indonesia, PV solar technology is widely available, yet its uptake remains limited due to a shortage of trained technicians to install and maintain the systems and poor after sales services. Given the challenges in providing the after-sale support, and in procuring the necessary spare parts, many households are reluctant to commit their own resources towards this technology. Thailand's application of solar power technologies has faced a similar lack of skilled manpower and technical capacity.

35. ***<u>Fifth</u>, limited public awareness leads to low consumer support and lower rates of CFT adoption***. In Indonesia, a lack of public education on a number of levels – including among technicians, government officials and the general public – on the economic benefits and costs of CFTs has also resulted in public resistance to adopting new CFTs. Households taking up new CFT products in Indonesia have faced issues concerning a lack of quality control, warranties, after-sales service and spare parts, further undermining the acceptance of these new technologies.

36. *Another example is from Thailand, where mobilizing consumer support has included the establishment of community level network of leaders through the 'Community Energy Volunteers' program.* This program developed community based prototype energy sources to demonstrate the ability of renewable energies to power communities. To build an energy saving culture, Thailand has implemented energy efficiency measures such as energy performance labeling of electrical appliances and mandatory provisions on standby power allowances through the "Standby power 1-watt" program. The government also provides incentives for the consumption of power generated by renewable energy through tax credits and privileges, and capital subsidies.

37. ***<u>Sixth</u>, high up-front costs of adopting CFTs, such as PV technology, at the household level can be a challenge for consumers***. Thus financing of CFTs at the household level is another challenge. Given the challenges in providing the after-sale support, and in procuring the necessary spare parts, many Indonesian households are reluctant to commit their own resources towards this technology. To overcome this barrier, the government's approach has often been to purchase the systems from private companies through a bidding process, and provide the systems to households for free.

38. ***Other issues with policy design can be found in China, Indonesia, Thailand, and Vietnam***.

- China has a number of laws and regulations to support the investment and up take of renewable technologies. However, policy targets are not framed in terms of achieving a useful output, but instead focus on installed capacity targets.
- Indonesia's ambitious energy targets may not be consistent with stated environmental aims due to their strong focus on the construction of coal-fired generation capacity.
- Thailand has announced various targets to increase the share of renewable energies. However, it is not clear how these would be implemented, given a lack of funding. Thailand may need to draw on funding support from external sources. Additionally, existing fossil fuel subsidies are likely to hamper the greater use of CFTs.
- Vietnam has similarly determined a range of renewable energy targets. The key impediments to the adoption of CFTs relate to a lack of information about the potential scope of these technologies in the country, but also low electricity prices that do not reflect true costs.

39. ***The country analyses identify CFTs that have the greatest potential in each country for expansion and diffusion***. For example, biomass, small/mini hydroelectric power and solar power have been identified as the CFTs with the greatest potential for expansion in Vietnam. At the same time, the country's potential for CFT trade is influence by its attractiveness as a low cost FDI location, and its scope for more CDM projects. These choices are presented in Table 3.5.

Table 3.5: CFT Potential by Country

Country	CFT energy potential	CFT trade potential
China	Clean coal Cogeneration Wind Small/micro hydro Solar Household & community biogas	Preferred location for FDI Key exporter of wide range of CFTs for South-North/North-South trade Key regional trading partner for South-South trade
Indonesia	Clean coal Solar Wind Geothermal Flared gas Biofuels	Key exporter of CFLs and forestry products Technology transfer with China to develop CCT, wind technology International collaborative efforts for CCT & other technologies
Thailand	Solar Wind	Key exporter of a range of CFTs Attractive FDI location Scope for securing more CDM projects
Vietnam	Biomass Small/micro hydro Solar	Attractive low cost FDI location Exporter of CFTs Scope for securing more CDM projects

4. MARKET READINESS

4.1 Introduction

1. ***Efficient market mechanisms reduce mitigation costs, facilitate financing of mitigation efforts, and are channels through which fiscal, trade and investment policies can reduce emissions*.** This chapter takes stock of existing market-based mechanisms that are currently being used by developed and some developing economies, and it discusses instruments which are being proposed as part of the architecture for a post-2012 climate agreement. The main finding is that several APEC economies and the East Asia region can already use fairly advanced market mechanisms to achieve mitigation in domestic markets or in bilateral trading. For this to happen, they will need to build institutional, technical and political capacity to manage the complexities of these systems. A fundamental requirement for using any of these mechanisms will be improved emissions inventories, and strengthened monitoring, reporting and verification (MRV) capabilities. A diagnostic approach to market readiness assessment is also proposed for APEC economies. Leading APEC economies can consider preparing themselves for the new market-based mechanisms and help shape the future of carbon markets.

2. ***Several APEC economies and the region can use a range of market-based instruments to increase incentives and financing for emissions reduction***. These instruments can support national or international mitigation objectives and facilitate voluntary reduction efforts by corporations and citizens worldwide in a cost effective manner. These instruments include:

- project-based offset mechanisms such as the Kyoto Protocol's Clean Development Mechanism (CDM) – possibly enhanced through appropriate reforms,
- sector-based crediting and trading mechanisms, if developed,
- crediting or payment systems based on nationally appropriate mitigation actions (NAMAs), if developed, and
- allowance-based emissions trading systems (cap and trade), such as the EU's emissions trading system.

In addition, APEC economies can also develop proxy-based systems, where renewable energy or energy efficiency certificates are traded or low-carbon technology are targeted.

3. ***These trading-based mechanisms are part of a broader range of market instruments that can be applied to climate change policy*** and which are discussed in earlier chapters. The additional policy instruments include fiscal instruments such as the removal of fossil fuel subsidies, taxes and levies on carbon-rich fuels and activities, or price incentives for low-carbon alternatives such as feed-in tariffs, tax breaks, concessionary grants, and capital markets measures to mobilize lower cost-of-capital equity and debt. Low-carbon / carbon neutrality requirements for certain activities and enterprises in addition to the promotion of voluntary mitigation measures and voluntary carbon markets can also play a role.

4. ***Market based instruments for GHG mitigation are already being used by developed and some developing economies*.** Table 4.1 provides some examples.

Table 4.1: Deployment of Select Market Mechanisms

Type of System	Economies / Regions
National emission trading systems	European Union, New Zealand
National emission trading systems (under discussion)	Japan, Korea, Australia (concrete plans stopped recently), USA
Regional / sub national emissions trading systems	Regional GHG Initiative (USA), Western Climate Initiative (USA)
Voluntary GHG reduction and trading (company-level)	Chicago Climate Exchange (USA)
Company-level GHG emission reporting	Mexico
Energy efficiency certificate trading	China (trial system), India (to be operational end 2010)
Renewable energy certificate (REC) trading	EU (some member states), India (operational end 2010)

5. ***The successful implementation of market-based instruments requires economies to have sufficient institutional and technical capacity***, which can be more or less demanding for the different instruments and which must usually be specifically tailored to each instrument's and economy's conditions. Typically, for the proper functioning of market-based instruments, there must be complementary systems for monitoring, reporting and verification (MRV). Similarly, arrangements for the validation, transaction and registration of emission credits must be in place to maintain the integrity of market-based systems. For offset systems, realistic baselines have to be established and for allowance-based system, the initial allocation of emission allowance will be critical.

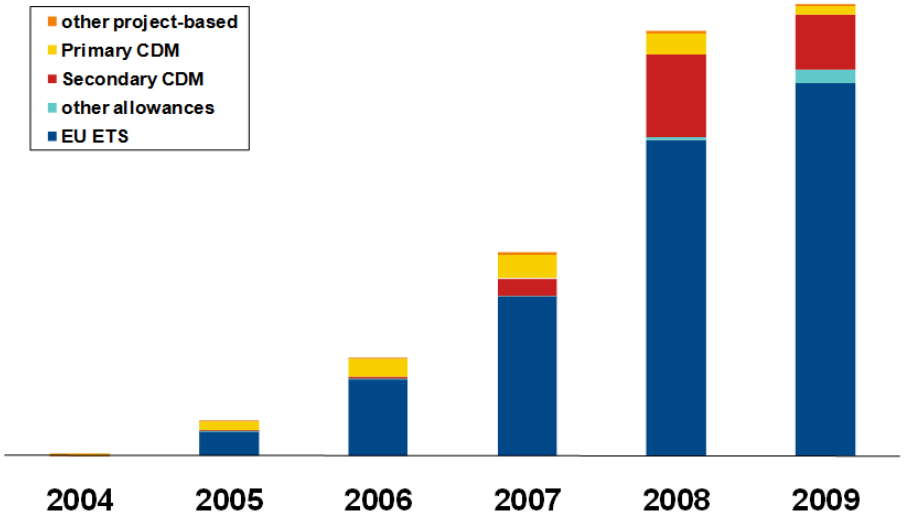
6. ***The chapter develops an approach and a diagnostic to rapidly assess an economy's capacity in the use of these market-based instruments*.** The assessment proposes to identify the readiness of APEC economies to successfully introduce market-based mechanisms and implement them broadly for scaling-up the market's response. The assessment identifies preconditions for domestic trading systems, but also discusses requirements for a possible linking of national trading and mitigation systems to international trading systems and mitigation policies.

4.2 Market-Based Instruments

7. ***The CDM was introduced by the Kyoto Protocol to allow developed economies with reduction targets to offset some of their emissions by achieving mitigation in developing economies*.** This was seen as contributing to the sustainable development agenda. The mechanism generates credits from projects in developing economies that are registered as CDM projects and which reduce emissions below a baseline level in compliance with the methodologies, modalities and procedures for the CDM. The CDM is a highly regulated international mechanism, supervised and managed by an Executive Board of experts appointed by the Meeting of the Parties to the UNFCCC.

8. ***In recent years, a brisk market has developed for trade in CDM assets: registered certified emission reductions (CERs)***, CER forward sales, Emission Reduction Purchase Agreement, and CDM projects. Sales are executed on established exchanges or over-the-counter (World Bank, 2010e). While CDM assets can be acquired by any entity, most of the demand stems from entities with mitigation obligation under the European emissions trading system. Figure 4.1 shows the development of the global carbon market until 2009.

Figure 4.1: Growth of the Carbon Market



Source: World Bank (2010e)

9. ***The owners of CERs can use them in several ways*:**

- Developed economies with binding Kyoto Protocol emissions targets (Annex I Parties) can use CERs to comply with their Kyoto reduction commitments.
- Economies with domestic emissions trading systems and/or other GHG reduction targets can allow the use of CERs as equivalent "currency" within their domestic systems. This is the case of the European ETS, which accepts CERs as equivalent to European allowances. Similarly, Japanese companies buy CERs for delivery to their government under a voluntary system. Governments may then use delivered CERs to comply with their Kyoto commitments, or they can retire them.
- The voluntary and retail market has developed in CERs and in emission reductions from projects regulated under voluntary schemes. Under these consumers, business or government entities purchase carbon credits to offset their emissions and become "carbon neutral". Such credits are then typically "retired", i.e. they will not be used to offset Kyoto commitments or otherwise mandated mitigation obligations, thus resulting in a global emission reduction beyond government commitments.

10. ***The CDM demonstrates the ability of markets to drive the financial flows required to reduce emissions relative to business as usual (BAU) trajectories.*** Developed through a "learning-by-doing" approach, the CDM has achieved impressive results. The overall emission reductions from CDM and Joint Implementation (JI) are expected to amount to more than 1 billion tonnes of CO_2e during the Kyoto Protocol's first commitment period of 2008 to 2012**.**

11. ***However, the CDM in its current form has several major limitations and has been criticized by NGOs and project developers alike for its shortcomings.*** The efficiency and effectiveness of the CDM are reduced due to complicated methodologies and lengthy procedures, a high degree of uncertainty for project investors, and a problematic incentive structure. In addition, questions abound regarding the equitable distribution of CDM projects among economies, with China being by far the dominant supplier and Sub-Saharan Africa benefiting very little.

12. ***Determining a project's additionality, or specific contribution to reducing emissions, remain unresolved challenges for many projects, which a reformed CDM can address.*** To be eligible for registration, projects must demonstrate that they are only undertaken because the CDM provides support– i.e. they have demonstrated "additionality". Additionality is often difficult to assess objectively due to its ambiguous nature. Similarly, another challenge is setting a credible baseline and project baselines are all too often hypothetical constructs. A CDM project baseline is expected to correctly describe and predict the scenario and related emissions levels that would prevail in the absence of the CDM. Although the CDM Executive Board provides methodological guidance for project types, many CDM projects face the concern that they do not meet the additionality and baseline criteria, while other projects find it difficult to come up with the data and meet other requirements necessary to pass the tests. Additionality and baseline determination are open to criticism, particularly if market and other conditions (including policies and regulations) change over time, and because project participants are rewarded if they successfully misrepresent additionality and exaggerate baselines. For instance, under a reformed CDM, additionality and baseline problems could be resolved if the Parties (through the CDM Executive Board) agreed on simple, clear and unambiguous additionality criteria and set standard baselines and emission factors for different project types.

13. ***The effectiveness of the CDM is also constrained by a high degree of political uncertainty regarding the CDM process and future market conditions.*** Lack of clarity on a post-2012 climate agreement and the longer term demand for emission reductions, as well as economies' plans to make use of market instruments to meet domestic GHG objectives is a significant risk for project developers and investors**.** Project-related uncertainty arises due to the complexity and unpredictability of the CDM registration and CER issuance processes and the long project lead times, which in turn lead to higher transaction costs. The market-related uncertainty stems from the *de facto* limitation of the CDM to the current commitment period of the Kyoto Protocol (i.e. the period for which economies have binding reduction commitments), which will conclude in 2012. This uncertainty is compounded by lack of agreement among Parties on post-2012 reduction commitments, which negatively impacts investments in long-term and large-scale GHG mitigation projects. The future of the CDM, in its current form is thus unclear as the multilateral negotiations to determine the next global climate agreement are still ongoing.

14. ***The CDM also faces concerns about its targeting and competitiveness impacts.*** CDM projects are concentrated in a small number of large developing economies and in a small number of sectors. While the distribution of CDM projects reflects market demand and supply conditions as well as CDM policy and support structure in the project economy, it is seen as politically problematic that many smaller and poorer developing economies receive little or no benefit from the CDM, while some fear that CDM revenues can further improve the market position of already potent international competitors. In response to these concerns, the EU has opened the next phase of its ETS only to least developed economies and is advocating a more comprehensive, sector-based trading system for more economically advanced economies.

15. ***CDM reforms are being discussed, and some are already being implemented, to enhance the attractiveness and functioning of the CDM.*** One such reform is programmatic CDM (i.e. a Program of CDM Activities, PoA), where an emissions baseline for a group of projects is developed (instead of for each project), to decrease transactions cost. This was done because transactions costs can be prohibitively high for smaller projects. In general, PoAs are complex to set up, and they are still riddled with regulatory uncertainty and liability issues, which limit their potential. As alternative or addition to PoAs, some propose to develop a "sectoral CDM", which would improve regulatory reliability and reduce transaction cost. Here, a common emissions baseline would be set for all projects within a given sector (or sub-sector, or project class) and economy; and emission sources within this sector would be eligible to receive CDM credits if they achieve verified emission reductions below the set baseline.

16. ***Sectoral crediting is a similar idea to simplify and scale up the mitigation impact of international offsetting mechanisms***, while at the same time limiting distortions created from the project-

by-project CDM. In sectoral crediting mechanism, an economy would agree to keep quantified emissions or the emission intensity of a specified sector below a certain, presumably low level, which would *a priori* be agreed with international partners (probably other economies) through an international process. The crediting baseline could be represented as a succession of baseline numbers over a period of time, and/or it could be formulated as a function of exogenous economic indicators. Other than the CDM, sectoral crediting would work at the sector aggregate level: a government would receive an equivalent amount of GHG reduction credits if it manages to keep emissions below the agreed crediting baseline during a certain commitment period, whereas there would be no consequence if the sector overshot the crediting baseline (or no-regrets trading).

17. ***Sectoral crediting systems have their share of complexity, and they require advanced government-level capacity.*** Government will have to conduct a detailed, transparent and standardized emissions inventory and mitigation analysis of the target sector, including its supply linkages with other sectors in order to propose a trustworthy crediting baseline. This will be necessary for both reaching domestic and international agreements and for implementing the sectoral crediting system. This analysis must provide the necessary background data for the baseline proposal and support the government policy decisions, which would be aimed at driving down the sector's emissions with the most suitable and efficient instruments. The government may use GHG credits or financial revenues obtained from the sectoral crediting system to provide incentives to emission sources and/or support the sector's adjustments to lower carbon operations.

18. ***Nationally Appropriate Mitigation Actions (NAMAs) may afford governments more flexibility and control over mitigation actions than sectoral approaches, and can be less demanding in terms of implementation capacity.*** NAMA refers to a set of policies and actions an economy can undertake as part of an overall commitment to reduce GHG emissions while drawing on financial assistance from developed economies for implementation. This mechanism, based in the UNFCCC's Bali Action Plan and part of the 2009 Copenhagen Accord, recognizes that different economies may take different nationally appropriate actions on the basis of equity and in accordance with common but differentiated responsibilities and respective capabilities. Specific NAMAs and related (financial) support would presumably be agreed with international partners. Declared NAMAs and support commitments could be registered internationally, possibly along with performance measures, and commitments could later be subject to review. While the exact rules are yet to be decided, some suggest issuing emission credits for NAMA-related reductions (NAMA crediting). This would allow trading on international carbon markets, which could help raise funds in support of NAMA implementation.

19. ***Allowance-based emissions trading systems (ETS) are conceptually the most elegant trading mechanism***, combining a firm emission cap with a flexible, supply/demand-driven emissions pricing regime, which translates into higher costs for emitters and lower emissions. The emission trading systems implemented and discussed mostly today are based on the 'cap and trade' approach, including the now classic SO_2 trading system in the USA and the European ETS. In this system, emissions are capped and emitters need to obtain emission 'rights' (permits or allowances) to exceed capped emissions. If actual emissions are lower than the allowances they hold for a given period, emitters can sell their excess allowances and/or carry them over to the next period. In a mature ETS, allowances are usually managed by emitters along with other input factors in their production process, assisted by a full market infrastructure of exchanges for allowances and derivatives. For instance, power producers need to buy allowances if they use cheaper but CO_2-richer coal for power generation.

20. ***ETS are highly standardized and regulated, which is critical for their success and requires a high level of regulatory capacity and "maintenance".*** Typically, an ETS must be supported by extensive capacity to collect and analyze data and monitor emissions. This capacity needs to be deployed before setting any emissions cap for the system and for individual covered sources, and before establishing points of obligation and allocate allowances to participants. A secure registry system is necessary to enable the trading and tracking of compliance. Monitoring emissions and the allocation of allowances are

among the regulators' most critical and difficult tasks. First, emitters may try to influence the determination of their emissions, and the emissions profile may be heavily impacted by economic factors over a period of time. Second, the process of allocating allowances will spark political lobbying by emitters attempting to secure the largest-possible allocation of (free) allowances. Both problems befell the EU ETS at its inception, leading to an initial cap that was too generous and threw the system's performance into question.

21. ***An ETS can generate substantial emissions reductions at lower costs***. For example, the reductions achieved by the SO_2 trading system in the USA have exceeded expectations at costs that were significantly lower than anticipated. More recently, the member states of the Regional Greenhouse Gas Initiative (RGGI) in the USA have capped their emissions from the power sector with the aim of reducing them by 10 percent by 2018 compared to 2009 emissions. This cap and trade system was implemented in 2009 through state regulations, and it is linked through allowance reciprocity. Around 87 percent of the allowances are auctioned quarterly. Offsets are limited to 3.3 percent of a plant's compliance obligation, but this limit can increase to 5-10 percent when allowance prices reach certain price ceilings, which helps to keep possible price spikes under control. The volatility of allowance prices in the European ETS has seemingly been large since its inception, but still smaller than the volatility in the global energy markets, in particular oil markets.

22. ***An ETS can be more complex to implement than other market-based mechanisms*** and it should be carefully considered whether an ETS is the instrument of choice under prevailing conditions. In particular, the political environment should be suited to cater for the needs of setting up an ETS, including public acceptance of creating and trading emission rights, and the economy should carefully assess its administrative and technical capacity to manage a cap and trade system. In summary, the designing and implementation of an ETS typically faces four major challenges:

- ***First, each ETS has to be designed with care.*** An early and broad debate on the general design of the system is crucial and limits surprises for all participants and the regulator. Dealing with new institutions and provisions takes time – for the state authorities, the regulated and intermediate entities. But getting as much as possible "right" from the outset will significantly reduce implementation risks later. While it is important to build a system which is open for adjustments later, possible linking with other trading systems should already be considered at the outset.

- ***Second, building institutional, managerial and technical capacity at regulator and participant levels at an early stage is critical for the successful implementation of an ETS.*** Technicalities can become political, and policy decisions may have to be made on many technical implementation issues. Reliable and consistent data are an essential basis for the cap-setting process. This data is usually not available when the system is designed. Therefore, data needs first to be collected for a suitably long period (at least one year) before the cap setting and allocation process can begin.

- ***Third, ETS program parameters and targets need to be periodically reviewed and adjusted,*** especially in the early years. Weak targets in the aforementioned RGGI could not be strengthened and also posed a problem for the EU ETS. Leakage and competitiveness problems can result from not making clear decisions about auctioning allowances vs. their free allocation. Auctioning can generate significant resources to support energy efficiency and renewables, but they can also be tapped by legislatures for other purposes.

- ***Fourth, the effectiveness, stability and liquidity of the ETS must be ensured to maintain public support.*** The inclusion in the ETS and a fair treatment of all comparable emission sources as well as a well-managed monitoring and compliance system are important to counter concerns over distortion of competitiveness due to the ETS. Setting a long-term target corridor within which target adjustments can be made as necessary, e.g. through short commitment periods or a "central bank"-like institution managing e.g. auction volumes, can provide a long-term planning horizon for participants while leveling price peaks at critical times and reducing market volatility.

23. ***The trading mechanisms discussed above can be implemented mutatis-mutandis in an international or domestic context*** – as long as governments are willing and able to create mitigation obligations through policies and legislation, thereby creating demand for offsets or allowances in compliance markets. This can be done either from outside the system, e.g. in the case of the CDM, or within the system, e.g. a system-wide cap in an ETS. Additionally, the promotion of voluntary action by private and public entities and consumers can generate some demand for carbon assets, albeit often at lower price levels, as the growth of the voluntary carbon market demonstrates.

24. ***The trading mechanisms can be linked-up or combined internationally or domestically*** as demonstrated by the EU's acceptance of CDM credits in the ETS. Linking has many advantages such as the creation of deeper and more efficient markets and, above all, the generation of a nationally and/or internationally efficient price signal as an incentive to exploit the most economical mitigation opportunities at large. However, linking requires careful harmonization of accounting rules and other regulations or the creation of gateways to guarantee the comparability and credibility of allowances and credits from different systems. The possibility of linking should therefore be considered during the system's design in order to avoid costly and disruptive system retrofits later.

4.3 Lessons on Readiness from China and Indonesia

25. ***The CDM has been widely deployed in China and to a lesser degree in Indonesia.*** The CDM illustrates the major issues that economies must consider when preparing to use market-based instruments. The CDM in China and Indonesia is supported by their strengths in four area**s:**

- ***Institutional capacity is able to provide the cross-sectoral cooperation across ministries and agencies.*** For example, in Indonesia, the National Council on Climate Change (NCCC or Dewan Nasional Perubahan Iklim) was established by the President as a national focal point on climate change policy. It has seven working groups and is supported by a secretariat responsible for capacity building and communication between different agencies. Similarly, China has built strong cross-ministerial coordination and planning capacity under the leadership of National Development Research Commission (NDRC) and has created administrative and research entities with specialized support functions such as the CDM Center.
- ***A clear framework guides and harmonizes the use of the CDM within each economy and across different sectors.*** China's Five Year Plans and Indonesia's sectoral roadmaps provide decision makers with key development planning information. In Indonesia's roadmap, emission projections, policy measures, and GHG reduction potential are provided, and CDM activities are identified by possible year of implementation, listing barriers and areas where support is needed. In China, priority areas for CDM projects and strict guidance on how to use CDM have reduced risks for project owners, CDM developers and buyers alike. The government's support for CDM combined with some early project successes mobilized a vibrant community of domestic CDM service providers, which opened sector after sector to CDM.
- ***Awareness programs enhance diffusion by informing industries about CDM and GHG mitigation opportunities.*** With a focus on renewable energy projects, the majority of Chinese CDM projects have been implemented across the less developed regions of China where wind and hydro resources are most abundant. This was facilitated by the establishment of regional CDM service centers, which provide CDM consultancy services and have created awareness of emission reduction opportunities at local levels.
- ***The CDM-related capacity thus built in the two economies has introduced many stakeholders to the concept of emissions trading, its advantages and difficulties***. Due to the CDM, ownership in and the trading of emission rights are no longer alien concepts. Interest is mounting in

developing economies, particularly in China, to use more advanced trading mechanism to address climate change, but also other environmental and energy-related problems.

4.4 Building a Market Readiness Program

26. ***Based on the CDM experience, it appears that more advanced market-based instruments would face several hurdles in China and Indonesia despite recent improvements in institutional capacity***. Both economies have developed institutional capacity to address climate change. This, together with recent economy-wide and sectoral plans for economic development in the face of climate change, is an excellent basis for starting to implement market-based instruments. However, the capacity of the existing institutions to collect and analyze source and sector specific information on GHG emissions and related mitigation opportunities will need to be enhanced. This, as well as the use of this information for the setting of sectoral emissions baselines or targets (and/or emission allowances) will require cross-ministerial coordination and support. The same is true for subsequent monitoring, reporting and verification efforts as they are needed to underpin the quality of the assets being traded. These needs, however, could be met by dedicated government support and a targeted readiness and piloting program.

27. ***Technical and policy coordination between the many entities that may be involved in the design and implementation of market-based systems can be a challenge.*** As an example, Table 4.2 lists relevant entities for China.

Table 4.2: Relevant Government Departments in China

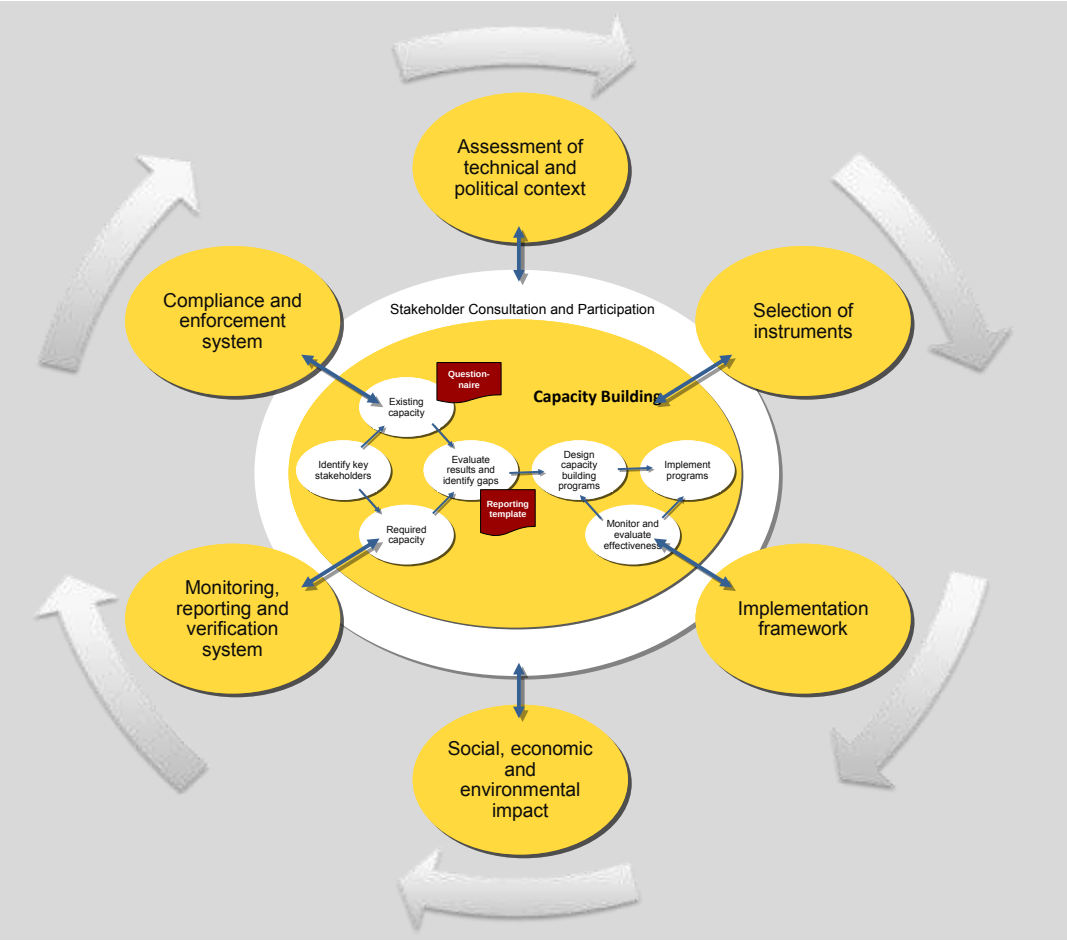
Direct climate change and energy conservation responsibilities	Direct industry oversight and regulatory responsibilities (power and cement)
- National Development and Reform Commission • Department of Climate Change • National CDM Project Management Center • Department of Resource Conservation and Environment Protection - National Coordination Committee on Climate change - National CDM Executive Board - National Bureau of Statistics	- Ministry of Industry and Information Technology - Ministry of Construction - NDRC, National Energy Administration - China Electricity Regulatory Commission (CERC) - State-owned Assets Supervision and Administration Commission (SASAC) - CEC- China Electricity Council - Large 5 State-owned Power Companies

28. ***Several steps have to be taken when preparing for the implementation of market-based instruments.*** Figure 4.2 shows the main steps, organized as a cycle, which may have to be completed more than once to refine the understanding of the selected market-based instrument and to fine tune its implementation framework. The steps are as follows:

- Prepare information drawing on economy and sector-wide emissions inventories and trajectories under different scenarios and identified potentials for mitigation action.
- Understand how the political and technical context will influence the choice of the market-based instrument and which effects the social, economic and environmental context will have on its performance.
- Select the instrument of choice and define its implementation framework.

- Study the selected instrument's social, economic and environmental impacts under different scenarios.
- Develop a monitoring, reporting and verification framework as well as compliance and enforcement mechanisms to ensure the integrity and effectiveness of the selected market-based system.

Figure 4.2: The Market Readiness Cycle



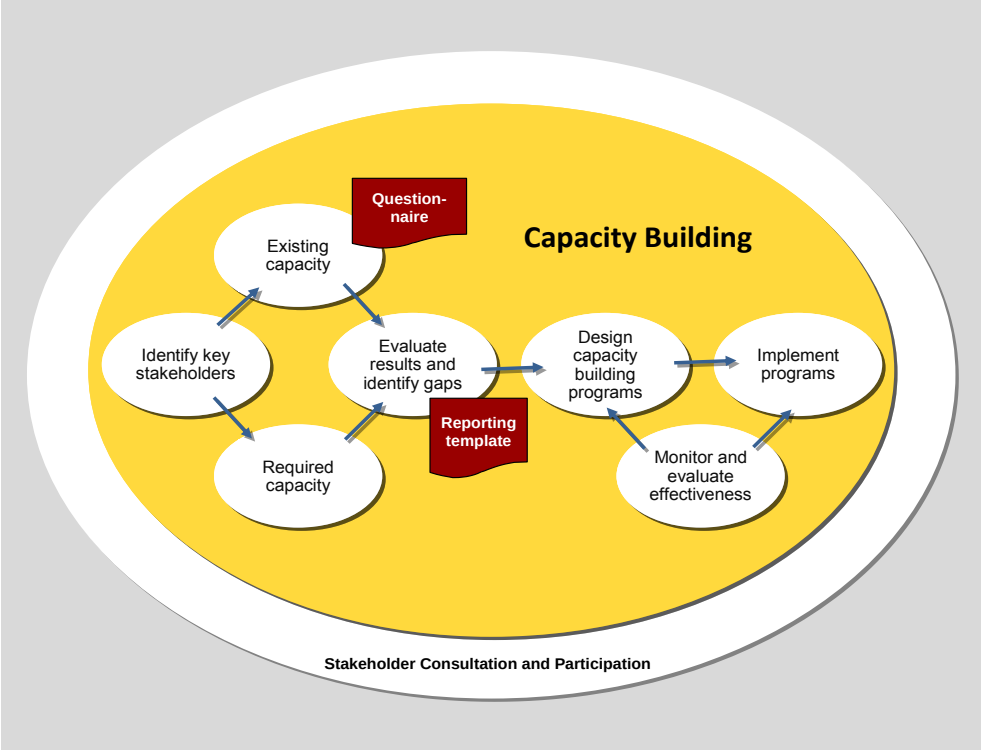
29. ***Capacity building is the central element in the overall process of preparing for market-based instruments, both in their design and implementation phase***. The need for additional capacity varies substantially depending on the economy's starting point, the selected instrument and the scope of the envisaged implementation.

30. ***The capacity building process follows a sequence of steps which may be repeated as needed*** (shown in Figure 4.3):

- Identification of the relevant stakeholders for the implementation of the specific instrument.
- Definition of the capacity that is needed for successfully instrument implementation.
- Identification of the relevant capacity that stakeholders already have.

- Determination of capacity gaps.
- Design of context-specific capacity building packages.
- Implementation of capacity building programs.
- Monitoring of effectiveness of the capacity building and assessment of remaining gaps.
- Second round of capacity building activities, as necessary.

Figure 4.3: Capacity Building Process



31. ***The design of a program for market readiness should embrace at least four strategic elements*** to encourage stakeholder support and institutional assistance with regard to the implementation and management of the market-based system. The key elements are:

- ***The readiness program should encourage positive, ownership-taking collaboration***. For example, placing a capacity building program within the broader context of "Low Carbon Green Growth" (a new concept quickly gaining traction in developing economies) can attract greater interest than a program that focuses narrowly on one of the carbon trading mechanisms.

- ***The target audience for a readiness program and its products should be broad.*** On the government side, it should include the economy's ministries and agencies of finance, energy, agriculture and forests, as well as legal and legislative experts that advise these agencies on the government's side. On the private sector side it should include concerned business interests including local financial institutions as well as civil society groups that wish to participate. To build collective ownership of concepts and implementation tasks, a readiness program should include joint stakeholder group meetings on strategy and policy as well as targeted sessions on implementation details and methodological issues.

- ***Readiness programs should learn from local and sector-specific best practice***. Identifying and sharing local success stories is important as best practice in advanced economies may have little practical relevance for the national circumstances of a developing economy. Readiness programs should include experts from other developing economies who can share practical experiences, successes and failures.
- ***An international readiness program should include small and mid-size developing economies alike to build regional support and prepare cooperation***. This suggests building a regional dimension into market readiness training for any specific economy.

32. ***The Word Bank is currently developing a Partnership for Market Readiness (PMR)*** in consultations with some developed and developing economies. Once launched, the PMR will be available to support all aspects of readiness programs for market-based mechanisms that go beyond the current CDM: strategy and planning, institutional capacity building, and the piloting of such instruments. The World Bank plans to continue the preliminary analytical work on market readiness on which this chapter reports. A more comprehensive policy note and a readiness questionnaire are already available. For Phase II, a much more detailed analysis of existing in-country capacity and of country readiness needs is planned.

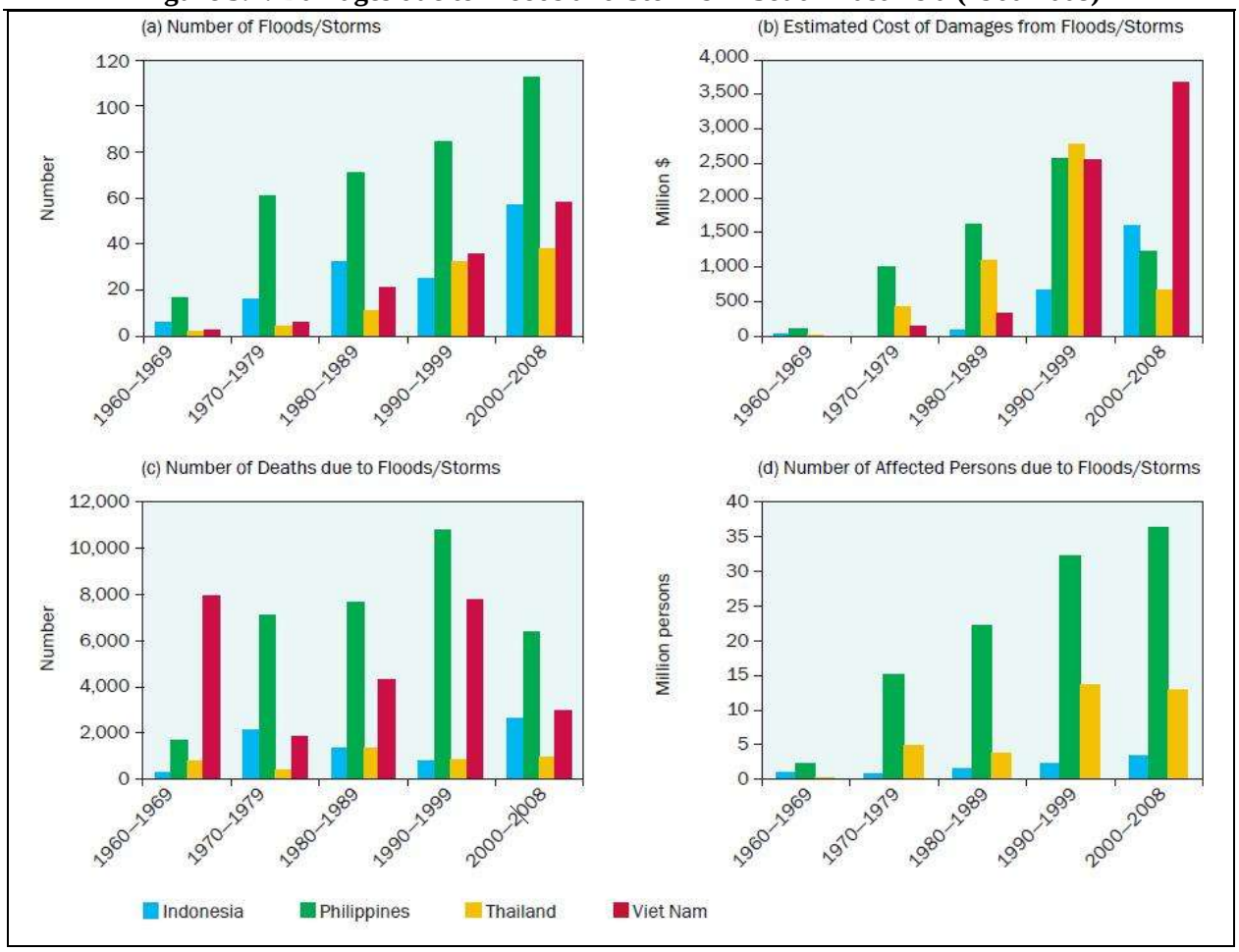
33. ***APEC Finance Ministers and Ministries will play an essential role in developing market readiness.*** First**,** Finance Ministers can support relevant line ministries and government agencies, and incentivize the private sector to enhance their institutional capacity, strengthen R&D on market-based instruments, and develop market readiness programs. They can achieve this by participating in the discussion on market-based instruments and by budgeting for readiness activities and for piloting of such instruments. Second, Finance Ministries may take the initiative among other ministries responsible for regulation and supervision, through helping them to enhance data availability, and develop a monitoring, reporting and verification framework. Third, Finance Ministries can cooperate with counterparts in other economies, and in regional and international organization to analyze and understand how market-based mechanisms will affect their economy's sustainable development and the global economy. Understanding the impact of these mechanisms will be crucial for making needed adjustments to fiscal, sectoral and overall economic policies.

5. EXTREME WEATHER EVENTS, HOUSEHOLD WELFARE, AND POLICY RESPONSES

5.1 Extreme Weather

1. ***As climate change continues, extreme weather events are predicted to happen more frequently in the East Asia and Pacific (EAP) region.*** China, Indonesia, Mexico, Thailand, and Vietnam – APEC member economies – are already among the most vulnerable in the world to floods and storms (World Bank, 2010a; World Bank, 2010b). As Figure 5.1 shows, the number of heavy storms and floods – natural disasters resulting from extreme weather – have been increasing in Indonesia, the Philippines, Thailand, and Vietnam. While economies have gotten better at reducing the number of deaths from these events due to better early warning systems and other policies, the higher frequency of these events has led to more people affected and greater economic damages (ADB, 2010).

Figure 5.1: Damages due to Floods and Storms in South-East Asia (1960-2008)



Note: Data not available for number of people affected in Vietnam
Source: Reproduced from ADB (2010), CRED (2008), CCFSC (2005)

2. ***The annual cost of adaptation to climate change in the EAP region, assuming a world that is 2 degrees Celsius warmer by 2050, is estimated to be between USD 18 and 22 billion between 2010 and 2050 – the highest of all the regions considered (World Bank, 2010f)***. However, the annual cost of adaptation and the vulnerability of the region to climate change vary across countries, and even across

sub-regions within countries. There is a great deal of variation in the vulnerability of different South-East Asian economies to climate change, with some economies like Vietnam and Indonesia exhibiting noticeable differences in their vulnerability between their northern and southern regions.

3. ***Weather extremes may have severe and long-lasting effects on development outcomes and household welfare***. Extreme weather events can adversely affect agricultural production, with severe and often long-lasting implications for food security, rural incomes, and poverty (Ahmed et al., 2009; Lobell et al., 2008). In the particular case of Indonesia, the impact of early-life rainfall was found to have major impacts on health, schooling and socioeconomic status (Maccini and Yang, 2009). For the cohort of men and women born between 1953 and 1974 in rural Indonesia, there was a strong relationship between early-life rainfall and the relevant long-run outcomes for women. These impacts can severely affect long run poverty reduction plans in economies.

4. ***These household impacts from weather extremes range widely, precluding any one-size- fits-all policies***. Table 5.1 summarizes the expected direction of impacts from weather events on two important dimensions of welfare: consumption and child health. The first column states the type of weather event, namely an extreme event or changes in rainfall or temperature outside the normal range. The second column describes the impacts on agricultural production and income. Both extremes of rainfall (drought or flood) and temperature (extremely cold or extremely hot) can negatively impact yields and thus, potentially, income and consumption as well. In general within a normal range of rainfall and temperature, additional rainfall or warmer days should increase yields. Malnutrition (and negative health outcomes) is possible, if food consumption is reduced as a result of an extreme weather event especially, if prior to the event the household or individual was barely consuming the required nutritional needs (column 3).

Table 5.1: Impact of Weather Conditions on Consumption and Health Outcomes in Rural Areas

Weather condition	Agricultural production / Income	Impact on consumption	Incidence of disease	Impact on health	
				From food consumption	Direct environmental
Extremely dry	Yields and livestock production will be lower.	Negative if cannot smooth consumption.	Generally reduces the prevalence of vector-borne diseases, but increases water/food-borne diseases	Negative, possible malnutrition, if cannot smooth food consumption	Indeterminate, but most likely positive
An increase in rainfall (within normal range)	Yields will increase with additional rain.	Total consumption should not decrease.	Increases the prevalence of both vector and water/food-borne diseases.	None or positive	Indeterminate, but most likely negative
Extremely wet	Yields will be lower.	Negative if cannot smooth consumption.	Increases the prevalence of both vector and water/food-borne diseases.	Negative, possible malnutrition, if cannot smooth food consumption	Negative
Extremely cold	Yields will be lower.	Negative if cannot smooth consumption.	May reduce the prevalence both vector and water/food-borne diseases.	Negative, possible malnutrition, if cannot smooth food consumption	Indeterminate, but most likely positive
An increase in temperature (within normal range)	Yields will increase with warmer temperatures.	Total consumption should not decrease.	Increases prevalence of both vector and water/born diseases.	None or positive	Indeterminate, but most likely negative
Extremely hot	Yields will be lower.	Negative if cannot smooth consumption.	Generally decreases prevalence of vector-borne diseases. Potentially increases water/food – borne diseases. Increases heat stress related health problems.	Negative, possible malnutrition, if cannot smooth food consumption	Indeterminate

Source: Skoufias et al. (forthcoming)

5. ***Policies like social safety net programs are "no-regrets", and are robust to the uncertainty of future climate change***. That is, the execution and expansion of these policies can benefit economies even under current climate, given that the EAP region already experiences more natural disasters than other regions of the world (World Bank, 2010f). The policies reflect how much extreme weather risk people are willing to bear, and focus on prevention, insurance against the risk, and relief and recovery at the community and government level. Table 5.2 describes some of the main policy measures in each of these categories.

Table 5.2: Policies for Adaptation to Extreme Weather Events

	Community	Government
Prevention	• Community training • Community-based information systems • Small scale irrigation and infrastructure projects	• Development of better information systems • Public works
Insurance	• Local borrowing and saving schemes • Microfinance • Cereal and grain banks	• Sovereign budget insurance • Catastrophe bonds
Coping (Relief and Recovery)	• Public employment guarantee schemes	• Cash transfers • Public Works • Disaster relief systems

Source: World Bank (2010g)

6. ***The presence of social safety net programs is critical for preventing long-term harm after a disastrous extreme weather event.*** This is especially true for children, where food shortages can lead to malnutrition, impairing cognition and reducing productivity and lifetime earnings (World Bank, 2010g). The need to make food available quickly may thus require that pre-existing stocks, plans, and systems that quickly disburse food aid are in place, such as food relief outlets. Evidence from other economies demonstrates the high impact of a well-developed social safety net program. During Ethiopia's 1995–96 drought, food aid offset the expected increase in child malnutrition (aged between 6 months and 2 years). In contrast, children in communities that experienced the drought but did not receive food aid experienced reduced growth (Yamano et al., 2005).

7. ***Efforts to reduce the vulnerability of household welfare from the adverse impacts of extreme weather events are thus closely linked to current government efforts towards reducing household vulnerability to poverty***. To a large extent, the factors that are associated with decreased vulnerability to poverty (e.g. better education, health, nutrition, access to financial markets etc,) are also the main factors that will help protect household from the adverse impacts of increased climatic variability, as noted by World Bank (2010f). This means that the building social safety nets in regions where they are non-existent and strengthening them in the regions where they are already in operation are key policy responses. They can be considered "no-regrets" policies that economies should consider implementing as part of a development agenda, if not as adaptation to climate extremes.

8. ***The case studies discussed in this chapter examine the impact of past extreme weather events in Indonesia, Mexico, and Vietnam and the policy measures that are associated with reduced impacts of these events.*** These studies utilize household survey datasets, detailed geo-referenced weather station and storm track data, and sophisticated statistical approaches to estimate the welfare impacts of the weather extremes. Table 5.3 summarizes the types of extreme weather event that is considered for each country and the preventive and coping policy issues that are examined.

Table 5.3: Coverage of Country Case Studies

	Indonesia	Mexico	Vietnam
Extreme Weather Event	delayed monsoon onset; low rainfall post monsoon onset	temperature and rainfall differences from historic average during agricultural growing period	drought, flash flood, river flood, hurricane force winds
Impacts	low rainfall more important than delayed onset; low rainfall reduces rural household welfare	warmer and drier weather than average is associated with higher per capita expenditures; colder weather decreases expenditures which decrease children's height-for-age	Frequent experience of disasters reduces welfare, while at times also reducing the immediate impact of a particular event due to adaptation; hurricanes are least frequent but do the most damage
Policy Considerations	Community based programs increasing access to credit and coverage by a safety net program all reduce welfare losses from low rainfall	Conditional cash transfer programs (PROGRESA) reduces impact of unusual weather on households	Irrigation effective in protecting against drought; presence of disaster relief systems important; private and public support systems largely elude hurricane stricken households or areas, indicating the need for more attention to assistance in case of hurricanes

5.2 Indonesia Case Study

9. ***Indonesia has been experiencing changes in both annual average temperature and rainfall.*** Since 1900, it is estimated that the annual mean temperature has increased about 0.3^{o} C. 1998 was the warmest year in the century, with the temperature 1° C above the 1961-1990 period average (PEACE, 2007). The increase in average temperature is projected to be as much as 0.5^{o} C by 2020. At the same time, overall annual precipitation has decreased by about 3 percent nationally, with significant regional differences (WWF, 2007). Southern regions have seen declines in annual rainfall, while northern regions on the other hand have experienced increases. Indonesia tends to experience droughts during the El Niño phenomenon and excessive rain during La Niña. With the possible exception of southern Indonesia, annual rainfall is expected to increase across the rest of the country in the future (Naylor et al., 2002).

10. ***The historical weather extremes have had noticeable impacts on the country, especially in agriculture***. The 1997-1998 El Niño droughts led to massive crop failures, water shortages and forest fires in parts of Indonesia. El Niño events tend to delay rainfall, leading to a decrease in rice planting in the main rice-growing regions in Indonesia such as Java and Bali. By 2050, changes in the mean climate could increase the probability of a 30-day delay in monsoon from 9-18 percent currently to 30-40 percent (Naylor et al., 2007). This delay combined with increase temperature could reduce rice yields by as much as 10 percent, soybean yields also by 10 percent, and maize yields by 50 percent.

11. ***The date of monsoon onset and the amount of post-onset rainfall are particularly important for annual rice harvests.*** Since farmers will typically begin planting after monsoon onset, and a late onset may reduce prospects for a second harvest later in the year. After planting, the rice fields need about 60-120 cm of rainfall during the 3-4 month grow-out period. Examination of climate data from 1979 to 2004 reveal that only provinces in Java experienced delays greater than one standard deviation from the 25 year average in 1999/2000. As for the amount of rainfall during the 90 day post-onset period (i.e. after the

monsoon has started), only provinces in Java experienced rainfall below two standard deviations from the 25 year average in 1999/2000. The regional variation in climate is thus critically important in understanding how rainfall patterns may change in the future.

12. ***Low rainfall after the onset of the monsoon, an associated with climate change, reduces the welfare of rice farmers***. If the amount of rainfall during the 90 day post-onset period is sufficiently below the average, the consumption of households engaged in rice farming falls significantly. In contrast, delays in monsoon onset are not found to have a significant effect on welfare (measured as food and non-food household expenditures). This may be indicative of adaptive behavior on the part of farmers as they adjust their planting dates.

13. ***There are two key findings. First, among communities that have experienced low rainfall, households in rural communities with access to specific community features tend to have significantly higher levels of consumption than similar households in communities without them***. These community features include irrigation facilities, the presence of community-based programs (Kampung Improvement Program[6] and Infrastructure Development Program), and availability of credit (Inpres Poor Villages Program[7]). Availability of credit has the strongest impact on both total expenditure and food expenditure. Infrastructure development is the next community characteristic with the strongest impact on the same two outcomes. Irrigation and Kampung development have significant impact only on total and non-food expenditure. The results also associated with access to credit suggest that households in those communities have the possibility to smooth their consumption. The results reveal that when only farm households are considered, irrigation is the sole community characteristic with significant influence on the welfare impact of the rainfall shock.

14. ***Safety net programs adopted in response to the 1997/1998 crisis are also found to dampen the welfare loss of low rainfall***. A village can have a Padat Karya program, a loose collection of labor-intensive programs sponsored by various government departments, a PDM-DKE (Regional Empowerment to Overcome the Impact of Economic Crisis) program, a block grant program for villages to support public works or revolving funds for credit, and the Inpres Desa Tertinggal (IDT) (Program for Underdeveloped Villages), another block grant program targeting extremely poor villages (Sumarto et al., 2002). These programs are found to also protect household consumption from low rainfall shocks.

5.3 Mexico Case Study

15. ***Mexico is highly vulnerable to weather fluctuations***. About 82 percent of cultivated land is rainfed (INEGI, 2007). Corn is produced in 59 percent of cultivated land in the wet season and 31 percent of the land in the dry season. The total area cultivated is more than six times greater in the wet season than in the dry season (INEGI, 2007). More importantly, corn is used by many small-scale farmers not only as a source of income but also directly as a subsistence crop. Switching to other crops, such as wheat or barley, which have a shorter growth cycle but are not as useful for household consumption, is considered a last resort (Eakin, 2000).

16. ***The average climate in Mexico is relatively dry and even a slightly drier than average year can cause substantial crop loss***. Droughts are responsible for more than 90 percent of all crop losses (Appendini and Liverman, 1994). Conde et al. (1997) find that an increase of 2°C and a 20 percent decrease in rainfall would increase the amount of unsuitable land for corn production by 8 percent in a sample of seven corn producing municipalities.

[6] The Kampung Improvement Program (KIP) is a settlement upgrading program. The program provides access to roads, footpaths, drainage, sewage solutions and drinking water and social facilities such as schools and health centers for urban low- and medium income groups in kampung settlements (UNESCAP, 1998).

[7] This is part of the Intruski Presiden (Presidential Instruction Program, or Inpres).

17. ***The study examines the impact of temperature on welfare and policy responses.***[8] Colder than average weather lowers household expenditures in rural areas, since it reduces yields and income. In terms of magnitude, a colder than average agricultural year translates to a significant 12 percent reduction in total household expenditures. In terms of policies, households with access to conditional cash transfer programs, such as PROGRESA are significantly less susceptible to the impacts of weather compared to households in other localities[9]. This study found that that the PROGRESA program reduced the detrimental impacts of lower temperatures. While in non-PROGRESA localities, lower temperatures lead to lower expenditures per capita by as much as 32 percent, in PROGRESA localities such an impact does not exist. These results would suggest that temperature does not play as important of a role in PROGRESA localities as in non-PROGRESA localities, i.e. households in localities with the program are able to insure against negative impacts from temperature shocks better than households in non-PROGRESA localities.

18. ***Significantly colder and warmer weather also has a direct impact on a child's height-for-age in addition to its indirect impact through lower household consumption.*** The results suggest that colder than average weather has a negative impacts on the nutritional status of girls less than thirty six months of age but not boys. The presence of a social safety net program is found to mitigate the negative impacts of extreme weather on child nutrition and health.

5.4 Vietnam Case Study

19. ***Vietnam is highly vulnerable to floods, cyclones and droughts.*** It ranks fourth in the world in absolute number of people exposed to floods and third in the percentage of population and GDP exposed to floods. The country is also ranked tenth in the world in absolute number of people exposed to high winds from tropical cyclones. Even in terms of drought exposure, it ranks sixteenth in terms of absolute number of people exposed to drought (UNISDR, 2009).

20. ***These weather-related shocks can reduce household income and consumption***. Droughts affect households involved in agriculture through crop and livestock loss, but they can also affect urban households through higher food prices (or food shortages) and through power outages following water shortages at hydroelectric plants. Floods can destroy crops and productive assets, disrupt the flow of commerce by wiping out roads and bridges, and kill people. Cyclones can do the same through coastal storm surges and destructive winds, usually causing even more damage to buildings and infrastructure. Cyclones, however, usually affect fewer people (Loayza et al., 2009).

21. ***Geographic exposure to natural hazards varies substantially.*** This is illustrated by Figure 5.2. Drought prone areas are mostly along the coast of the North and South Central Coastal provinces, and surprisingly also in the Red River (and to a lesser extent the Mekong River) Delta. High precipitation events that could lead to localized flooding appear concentrated in central Vietnam, while riverine floods (not depicted here) occur most frequently in the Red River and Mekong River Deltas, as expected. Areas in the North-central Coast and Northeastern Upland provinces are most frequently hit by tropical cyclones, up to once every five years.

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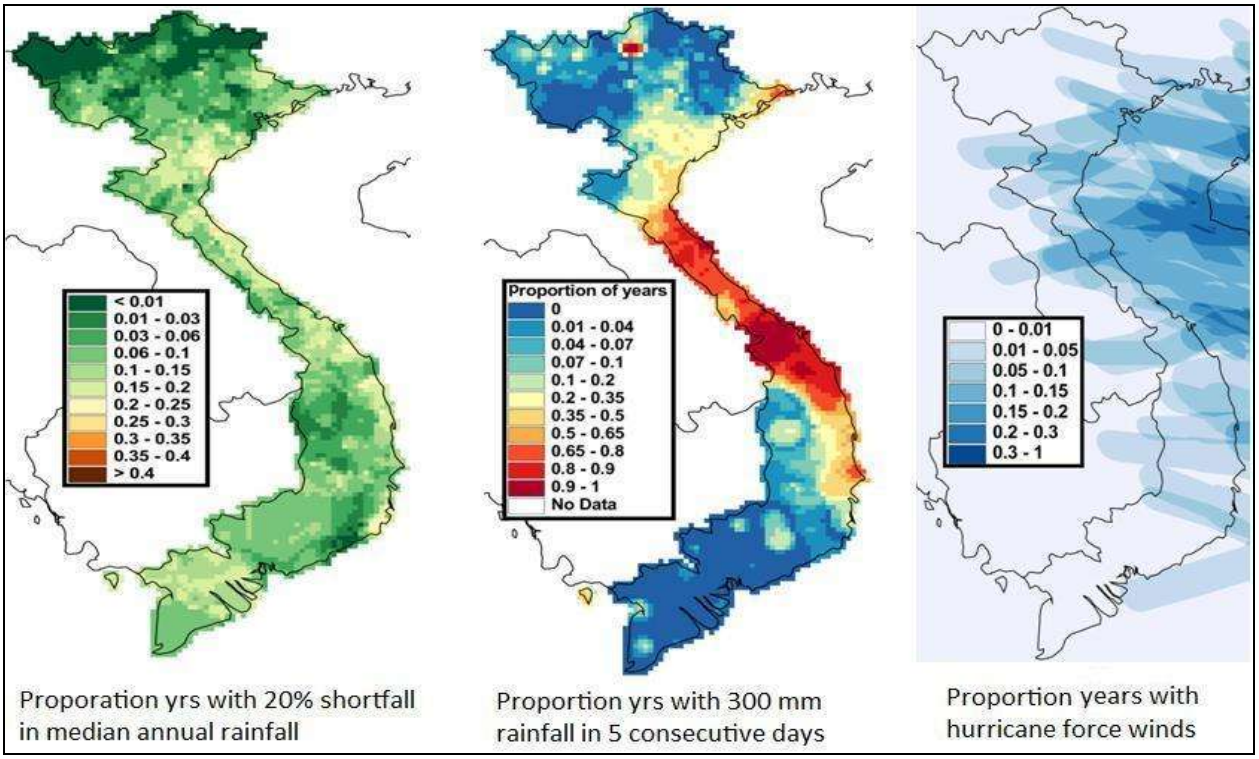
[8] From weather data, it accounts for the total rainfall and temperature for each agricultural year (October to September), for each wet season (April to September) and for the months leading to the canícula (mid-summer drought in April, May, and June), between 1951 and 2007.

[9] PROGRESA (Programa de Educación, Salud y Alimentación, i.e. the Education, Health, and Nutrition Program) is a targeted cash transfer program that promotes school attendance, health clinic visits, and nutritional support.

Figure 5.2: Geographical Exposure to Hazards Differs Widely in Vietnam

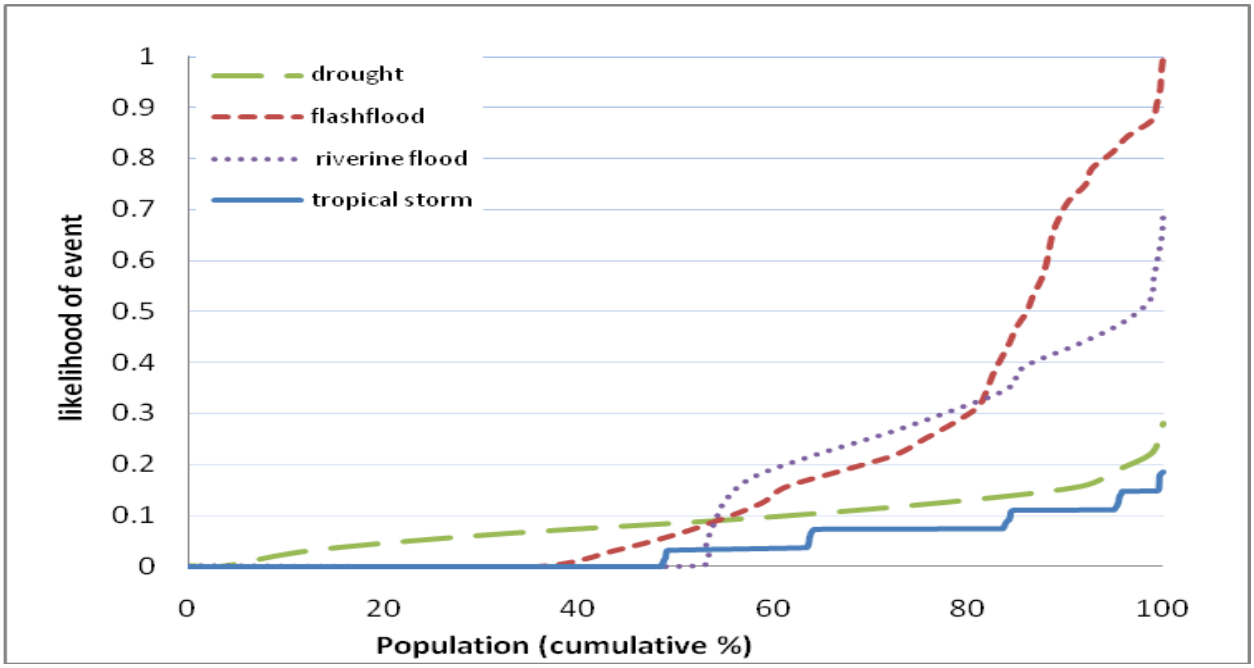


Source: Thomas et al. (forthcoming)

22. ***Other important findings of this research are:***

- ***While most households have some limited drought risk, twenty percent of the population has at least a 30 percent chance of being flooded each year.*** At the same time, about two fifths of the population will never be affected by a flood and half the population will never be affected by a storm. Figure 5.3 illustrates the cumulative distribution of the natural hazard rates and describes the frequency of these hazards faced by rural households.
- ***Areas frequently exposed to natural disasters are substantially poorer, with the associated welfare loss less pronounced further away from the large urban centers.*** Frequent exposure to natural hazards is most damaging in the case of droughts and tropical storms and closer to the metropoles. Households in areas frequently exposed to flash floods are also poorer. Cumulative asset loss and adaptation likely erode the asset base and induce the adoption of lower risk, lower return portfolios. However, in areas where rivers frequently exceed their banks, households appear richer, at least when not too far from the metropolis. In this study, it largely concerns households in the Mekong River Delta, who have their livelihood systems built around floods ("living with flood"). Indeed, when comparing self-reported flood measures with the riverine flood measure used in the study (taken from the Dartmouth Flood Observatory) there appears a much larger flood incidence based on the latter than the former, suggesting that not all floods recorded in the DFO are considered negative events by the households themselves.

Figure 5.3: One Fifth of the Population Lives in Areas that are Flooded at Least Once Every Three Years, While Two Fifths are Never Affected



Source: Thomas et al. (forthcoming)

- ***The occurrence of a drought[10] reduces consumption during the drought year by 16 percent. Higher incidence of droughts in an area and households with larger amounts of irrigated land decreases this loss.*** Unsurprisingly, irrigation effectively shields households from the effects of droughts; households with half their land irrigated experience only about half the consumption loss (8 instead of 16 percent). That regular exposure to drought further reduces its immediate welfare effects suggests that households have learned to adapt beyond the adoption of irrigation, which is more frequent in areas with more erratic rainfall patterns. An important strategy to cope with droughts ex post is to dispose of assets. This leads to an erosion of the asset base over time. When droughts hit frequently, especially among those households with few irrigated fields, is one reason why living standards are lower in areas with erratic rainfall patterns. Finally, note that the measure of droughts considered in this study concerns relative rainfall shortages. The frequency with which droughts occur does not depend on the median level of rainfall, but on the dispersion around this median. In other words, droughts can, in principle, occur with the same or even higher frequency in wet areas than in dry areas.

- ***Hurricanes cause most damage in Vietnam and can reduce per capita household consumption by up to 50 percent when they occur***. Moreover, unlike households that are frequently exposed to droughts or floods, households that experience hurricanes frequently, see their damages further compounded. There appears to be no adaptation by households to frequent exposure to hurricanes. Furthermore, disaster relief aid is unresponsive to hurricane events, an important area for further policy attention. As a result, the welfare loss and erosion of coping capacity following one hurricane are compounded by the next one, resulting in a substantially lower welfare among households in hurricane prone areas. Again, the substantial welfare loss is somewhat mitigated among households further away from the major urban centers.

[10] Drought is defined as annual rainfall more than 20 percent below the median.

- ***The recurring finding of lower welfare loss in case of droughts, flash floods and hurricanes among households far away from major cities remains somewhat puzzling and sheds critical light on where to target relief efforts.*** Remote households have fewer durable and fixed assets, have fewer irrigated land and receive fewer remittances both from within and outside Vietnam. In addition, while they tend to be more likely to receive disaster relief efforts in case of droughts or riverine floods, the amounts remote households receive tend to be substantially less than the amount households close to the metropoles receive. This leaves those in remote areas with substantially less capacity to cope with natural disasters ex post, likely inducing them to adapt ex ante, similar to households frequently exposed to disasters, by adopting less risky but also less remunerative portfolios to begin with. If so, this would provide support for an expansion of insurance and safety nets provisions in those remote areas to allow households to adopt more remunerative livelihood strategies.

23. ***Finally, the findings from Vietnam underscore the need for well-targeted disaster relief systems and the usefulness of disaggregated natural disaster and hazard maps for targeted policy interventions.*** One immediate application would be the use of such maps for developing hurricane relief systems. Current relief systems in Vietnam have largely eluded areas prone to hurricane force winds despite the fact that they cause greater damage to household welfare than floods or droughts. The study by Thomas et al. (forthcoming) demonstrates a methodology for constructing such disaster maps, an excellent starting point for similar mapping endeavors elsewhere.

6. REGIONAL COOPERATION IN APEC

1. ***As a regional body, APEC is well positioned to use regional cooperation to advance mitigation and adaptation policies to deal with climate change.*** APECs voluntary and non-binding framework may give it an advantage to make progress in these regional cooperation areas. This report identifies four areas of cooperation:

- Harmonizing trade policies to promote climate friendly technologies
- Coordinating regulatory systems
- Strengthening regional climate monitoring efforts
- Sharing Knowledge

2. ***Harmonized trade policies can substantially increase trade in environmental goods and services***. As was noted in Chapter 3, there are substantial tariff and non-tariff barriers (NTBs) to the trade of CFT products. The elimination of all barriers is estimated to increase global trade in clean coal technology, wind/solar power generation, and energy efficient lighting technology by more than 13 percent. Tariff peaks exist on several environmentally friendly goods in several economies, and these tariffs need to reviewed and removed. Beyond tariffs, NTBs like standards, certifications, subsidies and environmental regulations present difficulties to CFT products from developing economies to enter the markets of developed. However, if APEC economies harmonized their labeling and certification of CFT products, the international trade, and subsequent usage of the technologies is expected to increase. The "Energy Star" labeling program for energy efficient consumer electronics already in use in some APEC economies illustrates how voluntary labeling programs can help promote energy efficient products. Another action here would be to review and remove tariff peaks on environmentally friendly goods.

3. ***Coordinating in regulatory systems can increase incentives for investment and help markets grow***. Harmonized regulatory mechanisms across geographically broad jurisdictions can create and encourage the growth of regional markets for climate friendly products. For example, several economies have begun to phase incandescent light bulbs for energy efficiency reasons. As these bulbs are phased out, the market of compact fluorescent lights (CFLs) and other high-efficiency lights are increasing. With the expansion in the market for these products, there are corresponding increases in production and international trade. As was noted in earlier chapters, several middle-income APEC economies have potential to become major producers and exporters of these CFTs, and they would benefit from these coordinated regulatory systems.

4. ***Emissions reduction and long-run climate change adaptation measures can be better planned by stronger regional climate monitoring efforts***. As the World Development Report 2010 (World Bank, 2010a) notes, institutions with strong technical capacity for climate analysis are important for understanding climate change. To that end, providers of global climate services (GCS) can provide critical information needed to better plan for and anticipate climate conditions. Regional GCS providers GCS can provide a regional framework to integrate climate analysis and forecasting services. The WDR 2010 identifies the Pacific Climate Information System as a nascent regional provider of these services, facilitating pooling of resources and expertise, and identification regional priorities. Regional collaboration is even more important for systems such as early warning systems. The Pacific Tsunami Early Warning system is critical for disaster management, and several APEC member economies are already affiliated with this mechanism.

5. ***Knowledge sharing through regional cooperation can substantially enhance technical and institutional capacity in areas such as MRV of emissions.*** As was noted in this report, insufficient technical and institutional capacity is making it difficult for some middle-income APEC economies to implement their mitigation and adaptation to their utmost effect. For example, in Chapter 4, capacity gaps were identified as being a severe constraint to the efficient operation and expansion of the CDM. Given that there are differences in capacity across APEC economies, there is an opportunity for more developed economies to enhance capacity in other economies in the region. Cooperation between APEC economies in areas such as MRV protocols, would also contribute to the global climate negotiation process under the UN Framework Convention on Climate Change by strengthening trust among key partners. Regional cooperation and leadership through international initiatives can also facilitate knowledge sharing and skill transfer. The World Meteorological Organization's regional climate centers illustrate how regional cooperation can expand the provision of climate information services and facilitate knowledge sharing. Several of these centers are based in APEC economies, including centers in Beijing, Melbourne, Seoul, and Tokyo.

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